BOLTON

TM 11-6615-204-12

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR'S AND ORGANIZATIONAL
MAINTENANCE MANUAL

AUTOMATIC FLIGHT CONTROL SYSTEM

AN/ASW-12(V)

HEADQUARTERS, DEPARTMENT OF THE ARMY

30 AUGUST 1960

WARNING

This system uses 115 volts.

Be careful.

Do not make contact with exposed wires or connectors.

Be safe.

Turn all power supplies OFF before making any connections or disconnections.

DON'T TAKE CHANCES!

TECHNICAL MANUAL
No. 11-6615-204-12

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *30 August 1960*

AUTOMATIC FLIGHT CONTROL SYSTEM AN/ASW-12(V)

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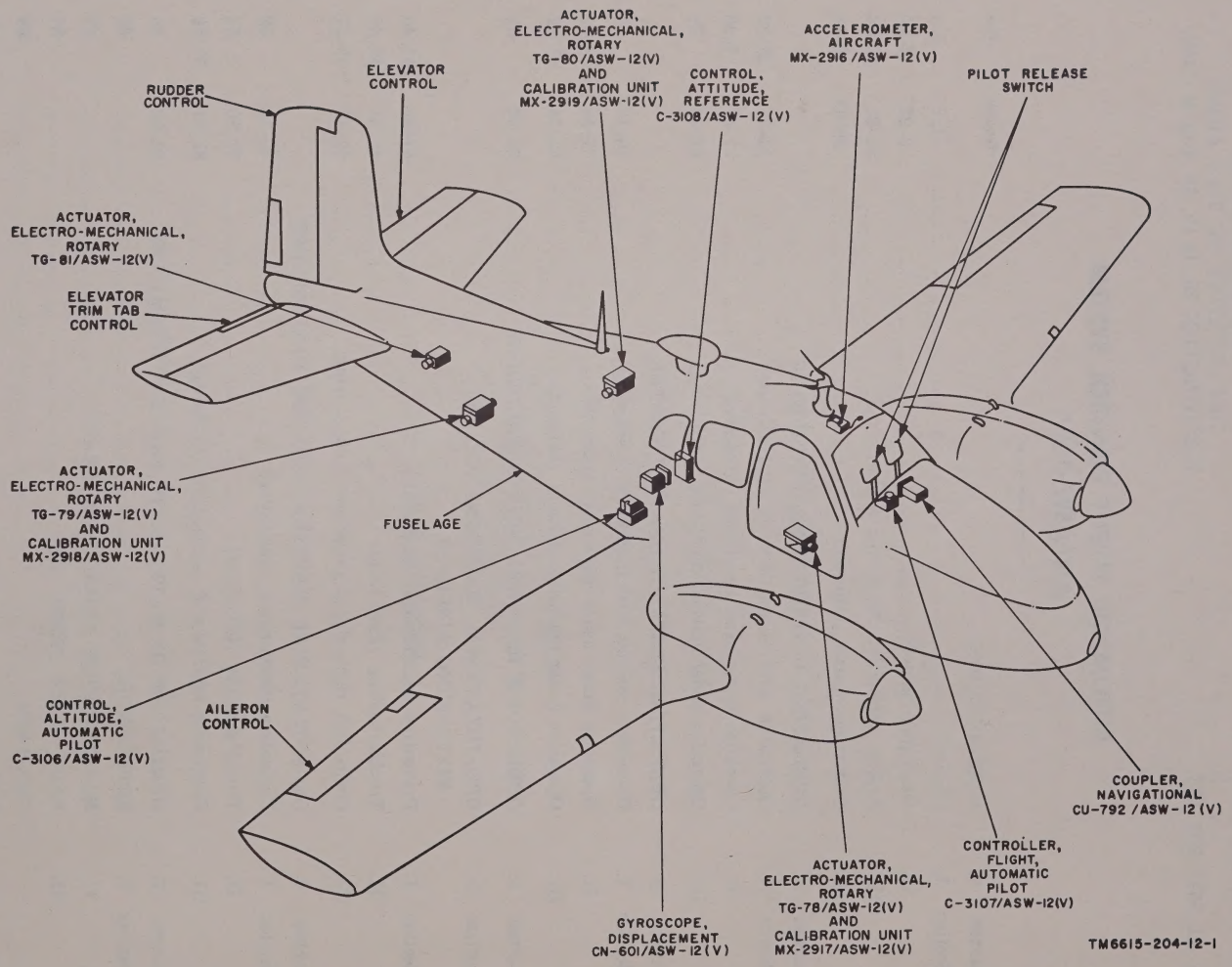

Figure 1. Automatic Flight Control System AN/ASW-12(V) component location, fixed-wing aircraft.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual describes Automatic Flight Control System AN/ASW–12(V) and covers its operation and operator and organizational maintenance. It includes operation under usual and unusual conditions, application of the system to manned fixed-wing aircraft (fig. 1) or unmanned fixed-wing aircraft (drones) and rotary-wing aircraft (fig. 2), operator adjustments and inspections, and organizational (second echelon) maintenance.

b. The components of the Automatic Flight Control System AN/ASW–12(V) covered in this manual, although specifically designed for use with fixed-wing installations, have multiple uses in that they may also be used in rotary-wing aircraft. When used in a rotary-wing installation, additional components are required. These additional components have not been assigned nomenclature and have not been assigned as components of the AN/ASW–12(V). Throughout this manual, the term

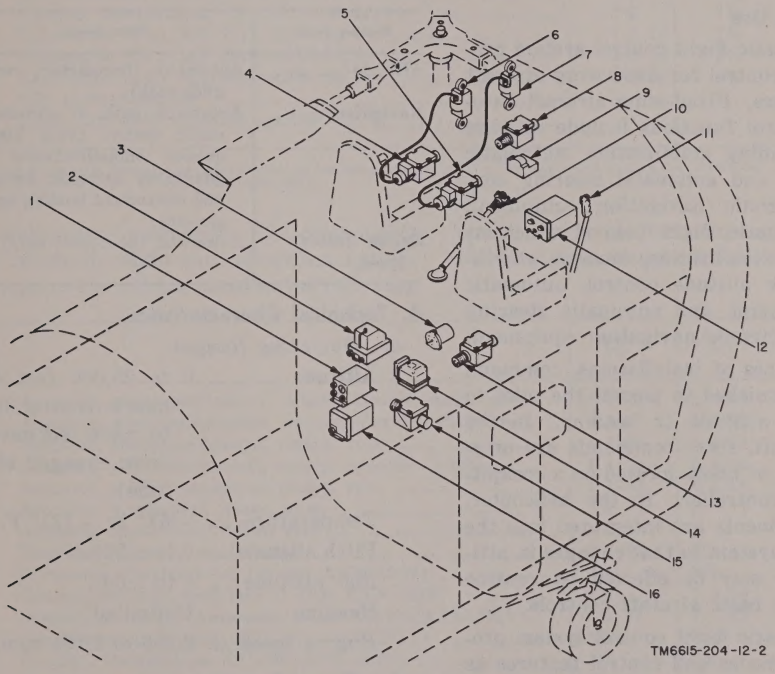

Figure 2. Automatic flight control system component location, helicopter.

1 Control, Attitude, Reference C–3108/ASW–12(V)
2 Control, Altitude, Automatic Pilot C–3106/ASW–12 (V)
3 Transducer, rotary motion, rpm
4 Actuator, electromechanical, rotary, flexible shaft, roll, and calibration unit, roll
5 Actuator, electromechanical, rotary, flexible shaft, pitch, and calibration unit, pitch
6 Actuator, mechanical, linear, roll
7 Actuator, mechanical, linear, pitch
8 Actuator, electromechanical, rotary, yaw, and calibration unit, yaw
9 Accelerometer, Aircraft MX–2916/ASW–12(V)
10 Switch, control, rpm
11 Pilot release switch
12 Coupler, Navigational CU–792/ASW–12(V)
13 Actuator, electromechanical, rotary, collective pitch, and calibration unit, collective pitch
14 Gyroscope, Displacement CN–601/ASW–12(V)
15 Actuator, electromechanical, rotary, rpm, and network, sensing, rpm
16 Control, command, collective pitch

automatic flight control system is used to designate either the AN/ASW–12(V) as installed in a *fixed-wing* aircraft or the AN/ASW–12(V) with the nonnomenclatured components as installed in a *rotary-wing* aircraft.

2. Forms and Records

a. Unsatisfactory Equipment Reports.

(1) Fill out and forward DA Form 468 (Unsatisfactory Equipment Report) to the Commanding Officer, U. S. Army Signal Materiel Support Agency, ATTN: SIGMS-MLM, Fort Monmouth, N. J., as prescribed in AR 700–38.

(2) Fill out and forward AF TO Form 29 (Unsatisfactory Report) to the Commander, Air Materiel Command, Wright-Patterson Air Force Base, Ohio, as prescribed in AF TO 00–35D–54.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700–58 (Army).

c. Comments on Manual. Forward all other comments concerning this publication directly to the Commanding Officer, United States Army Signal Materiel Support Agency, ATTN: Pub Engrg Dept, Fort Monmouth, N. J.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. The automatic flight control system provides automatic control for fixed-wing aircraft and for helicopters. Fixed-wing aircraft automatic flight control functions include attitude stabilization, heading stabilization, automatic altitude control, and automatic steering control from electronic navigation equipment. Helicopter automatic flight control functions include attitude stabilization, heading stabilization, automatic altitude control, automatic engine speed control, and automatic steering control from electronic navigation equipment.

b. In both types of installations, command functions are furnished to permit the pilot to select preferred attitude or heading. In the fixed-wing aircraft, these commands are originated by motion of knobs located on a cockpit-mounted flight controller. In the helicopter, the command elements are integrated into the primary control system so that changes in attitude or heading may be effected by routine movement of the basic aircraft controls.

c. The automatic flight control system provides operating modes and control features as indicated below:

Operating modes	Control features
Pitch attitude	Automatic or pilot command, up to ±35°.
Roll attitude	Automatic or pilot command, up to ±60°.
Heading	Automatic coordinated turns, or pilot command.
Altitude	Automatic (barometric, radar, or glide path).
Navigation	Automatic path, or enroute automatic control (very high frequency omnidirectional range, integrated Doppler navigation, and instrument landing approach system).
Engine (rotor) speed.	Automatic (helicopter only).

4. Technical Characteristics

a. Operating Ranges.

Altitude	0 to 25,000 feet (barometric control limited to ±400 feet deviation from engaged altitude).
Temperature	—67° to +131° F.
Pitch altitude	0 to ±35°.
Roll attitude	0 to ±60°.
Heading	Unlimited.
Engine speed	2,200 to 2,700 rpm.

b. Power Supply.

Direct current ..	27 volts, peak 14 amp.
Alternating current.	115 volts, 400 cps, peak 138-voltamperes.

c. Calibration .... Various resistance and capacitance networks; all calibrations are fixed in factory test

and do not require field adjustment.

d. Testing Facilities. Test plugs furnished for each system; also test points available in the components.

5. Components of Automatic Flight Control System

a. Fixed-Wing Components. The components of the automatic flight control system for use in fixed-wing aircraft (fig. 3) are listed in the following chart:

Quantity	Item	Height (in.)	Depth (in.)	Width (in.)	Unit weight (lb)
1	Actuator, Electro-mechanical, Rotary TG–78/ASW–12(V).	4 1/32	8 3/16	4⅝	5.5
1	Actuator, Electro-mechanical, Rotary TG–79/ASW–12(V).	4 1/32	8 3/16	4⅝	5.5
1	Actuator, Electro-mechanical, Rotary TG–80/ASW–12(V).	4 1/32	8 3/16	4⅝	5.5
1	Actuator, Electro-mechanical, Rotary TG–81/ASW–12(V).	2⅞	9	3¾	3.5
1	Gyroscope, Displacement CN–601/ASW–12(V)	4⅞	6⅞	7⅝	5.0
1	Control, Attitude, Reference C–3108/ASW–12(V)	4⅞	7 5/16	3⅛	4.5
1	Control, Altitude, Automatic Pilot C–3106/ASW–12(V)	5 5/32	7 7/16	4¾	3.2
1	Controller, Flight, Automatic Pilot C–3107/ASW–12(V)	4 9/16	4¾	3¾	1.5
1	Accelerometer, Aircraft MX–2916/ASW–12(V)	2⅝	2¾	2⅝	1.0
1	Coupler, Navigational CU–792/ASW–12(V)	3⅝	7⅞	5¾	4.5
1	Calibration Unit MX–2917/ASW–12(V)	1 3/16	1⅝	2½	0.2
1	Calibration Unit MX–2918/ASW–12(V)	1 3/16	1⅝	2½	0.2
1	Calibration Unit MX–2919/ASW–12(V)	1 3/16	1⅝	2½	0.2
2	TM 11–6615–204–12				
6	Lamp, AN 3140 (running spares)				

Note. The above type designations are variable, as indicated by the "(V)". The particular application shown for the actuators and calibration units applies to one aircraft installation only.

b. Helicopter Components. The components of the automatic flight control system for use in helicopters (fig. 4) are listed in the following chart. Some of the components listed below have not been assigned nomenclature.

Quantity	Item	Height (in.)	Depth (in.)	Width (in.)	Unit weight (lb)
1	Actuator, electromechanical, rotary, flexible shaft, pitch.	4 1/32	8 3/16	4⅝	5.5
1	Actuator, electromechanical, rotary, flexible shaft, roll.	4 1/32	8 3/16	4⅝	5.5
1	Actuator, electromechanical, rotary, yaw	4 1/32	8 3/16	4⅝	5.5
1	Actuator, electromechanical, rotary, collective pitch	4 1/32	8 3/16	4⅝	5.5
1	Actuator, electromechanical, rotary, rpm	4 1/32	8 3/16	4⅝	5.5
1	Actuator, mechanical, linear, pitch	2⅝	5	1⅝	2.0
1	Actuator, mechanical, linear, roll	2⅝	5	1⅝	2.0
1	Transducer, rotary motion, rpm	3 3/64	3⅝	3 3/64	0.3
1	Gyroscope, Displacement CN–601/ASW–12(V)	4⅞	6⅞	7⅝	5.0
1	Control, Attitude, Reference C–3108/ASW–12(V)	4⅞	7 5/16	3⅛	4.5
1	Control, Altitude, Automatic Pilot C–3106/ASW–12(V).	5 5/32	7 7/16	4¾	3.2
1	Accelerometer, Aircraft MX–2916/ASW–12(V)	2⅝	2¾	2⅝	1.0
1	Coupler, Navigational CU–792/ASW–12(V)	3⅝	7⅞	5¾	4.5
1	Control, command, collective pitch	3¾	7	3½	2.0
1	Calibration unit, pitch	1 3/16	1⅝	2½	0.2
1	Calibration unit, roll	1 3/16	1⅝	2½	0.2
1	Calibration unit, yaw	1 3/16	1⅝	2½	0.2
1	Calibration unit, collective pitch	1 3/16	1⅝	2½	0.2
1	Network, sensing, rpm	2⅝	2½	1⅝	0.3
1	Switch, control, rpm	1½	3⅛	1 5/16	0.4
2	TM 11–6615–204–12				
6	Lamp, AN 3140 (running spares)				

Note. The above type designations are variable, as indicated by the "(V)". The particular application shown for the actuators and calibration units applies to one aircraft installation only.

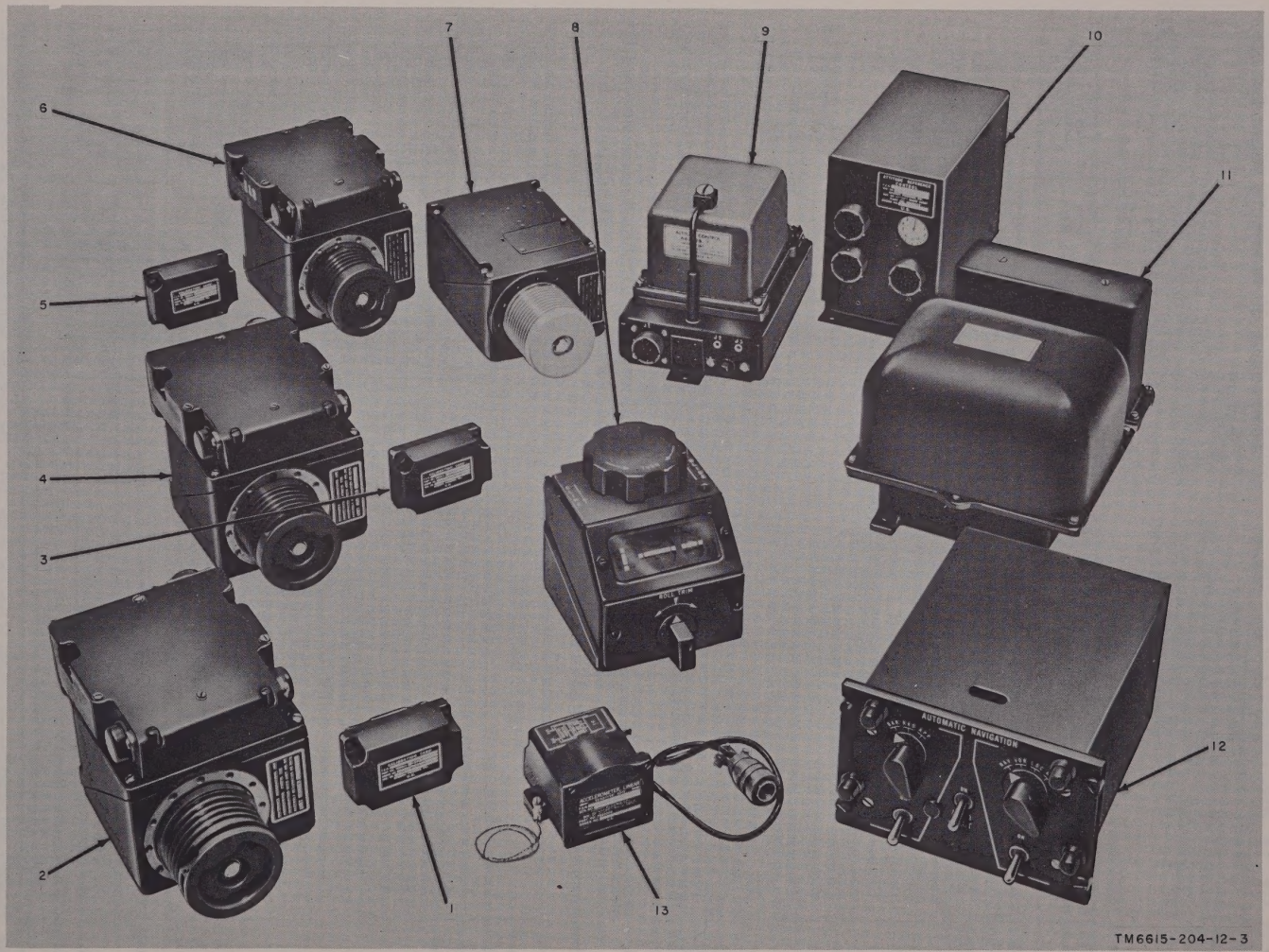

Figure 3. Fixed-wing components of automatic flight control system, less technical manuals and running spares.

1 Calibration Unit MX–2917/ASW–12(V)
2 Actuator, Electro-mechanical, Rotary TG–78/ASW–12(V)
3 Calibration Unit MX–2918/ASW–12(V)
4 Actuator, Electro-mechanical, Rotary TG–79/ASW–12(V)
5 Calibration Unit MX–2919/ASW–12(V)
6 Actuator, Electro-mechanical, Rotary TG–80/ASW–12(V)
7 Actuator, Electro-mechanical, Rotary TG–81/ASW–12(V)
8 Controller, Flight, Automatic Pilot C–3107/ASW–12(V)
9 Control, Altitude, Automatic Pilot C–3106/ASW–12(V)
10 Control, Attitude, Reference C–3108/ASW–12(V)
11 Gyroscope, Displacement CN–601/ASW–12(V)
12 Coupler, Navigational CU–792/ASW–12(V)
13 Accelerometer, Aircraft MX–2916/ASW–12(V)

Figure 3 — Continued.

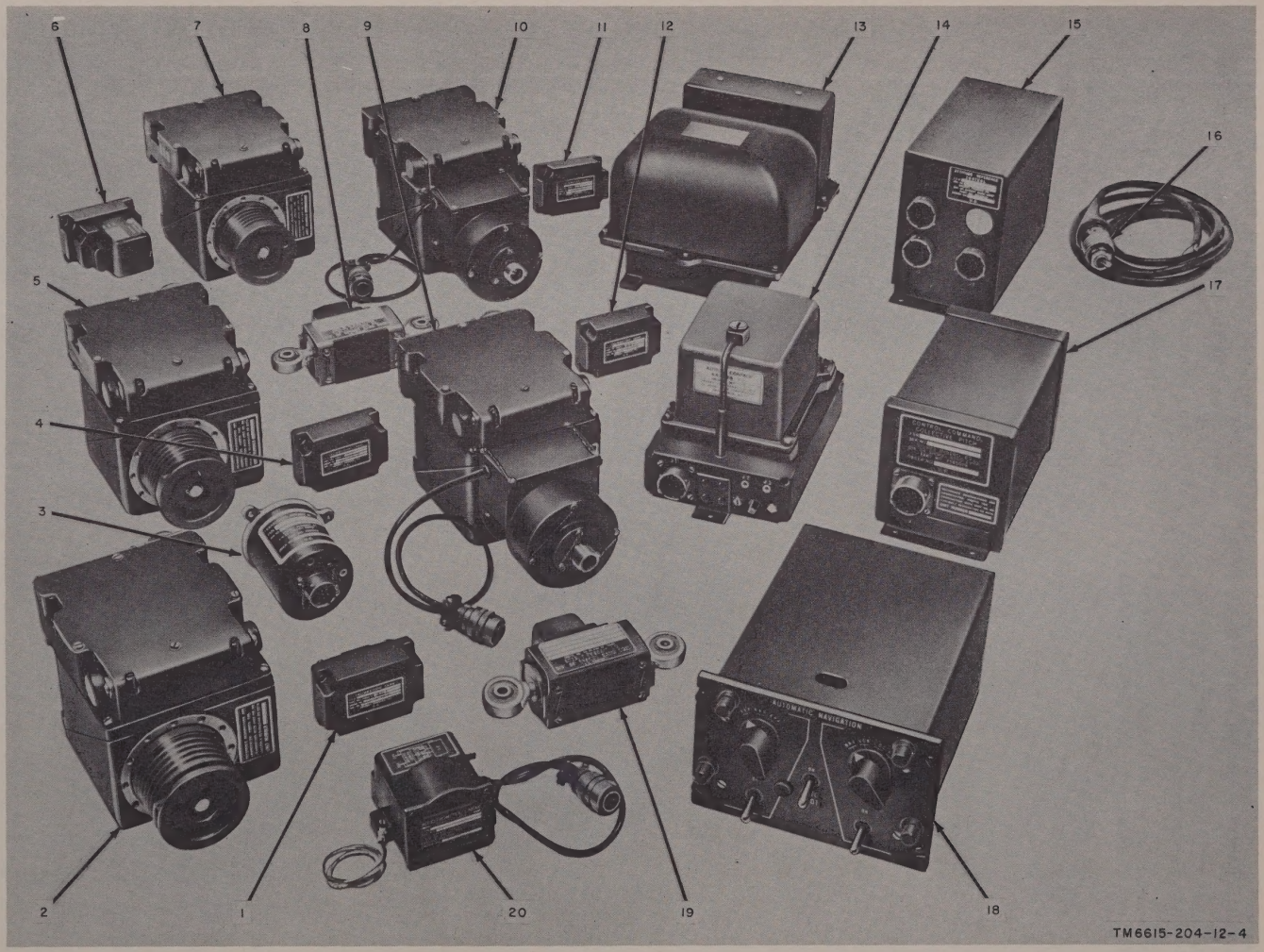

Figure 4. Helicopter components of automatic flight control system, less technical manuals and running spares.

1 Calibration unit, yaw
2 Actuator, electromechanical, rotary, yaw
3 Transducer, rotary motion, rpm
4 Calibration unit, collective pitch
5 Actuator, electromechanical, rotary, collective pitch
6 Network, sensing, rpm
7 Actuator, electromechanical, rotary, rpm
8 Actuator, mechanical, linear, pitch
9 Actuator, electromechanical, rotary, flexible shaft, pitch
10 Actuator, electromechanical, rotary, flexible shaft, roll
11 Calibration unit, roll
12 Calibration unit, pitch
13 Gyroscope, Displacement CN–601/ASW–12(V)
14 Control, Altitude, Automatic Pilot C–3106/ASW–12(V)
15 Control, Attitude, Reference C–3108/ASW–12(V)
16 Switch, control, rpm
17 Control, command, collective pitch
18 Coupler, Navigational CU–792/ASW–12(V)
19 Actuator, mechanical, linear, roll
20 Accelerometer, Aircraft MX–2916/ASW–12(V)

Figure 4 — Continued.

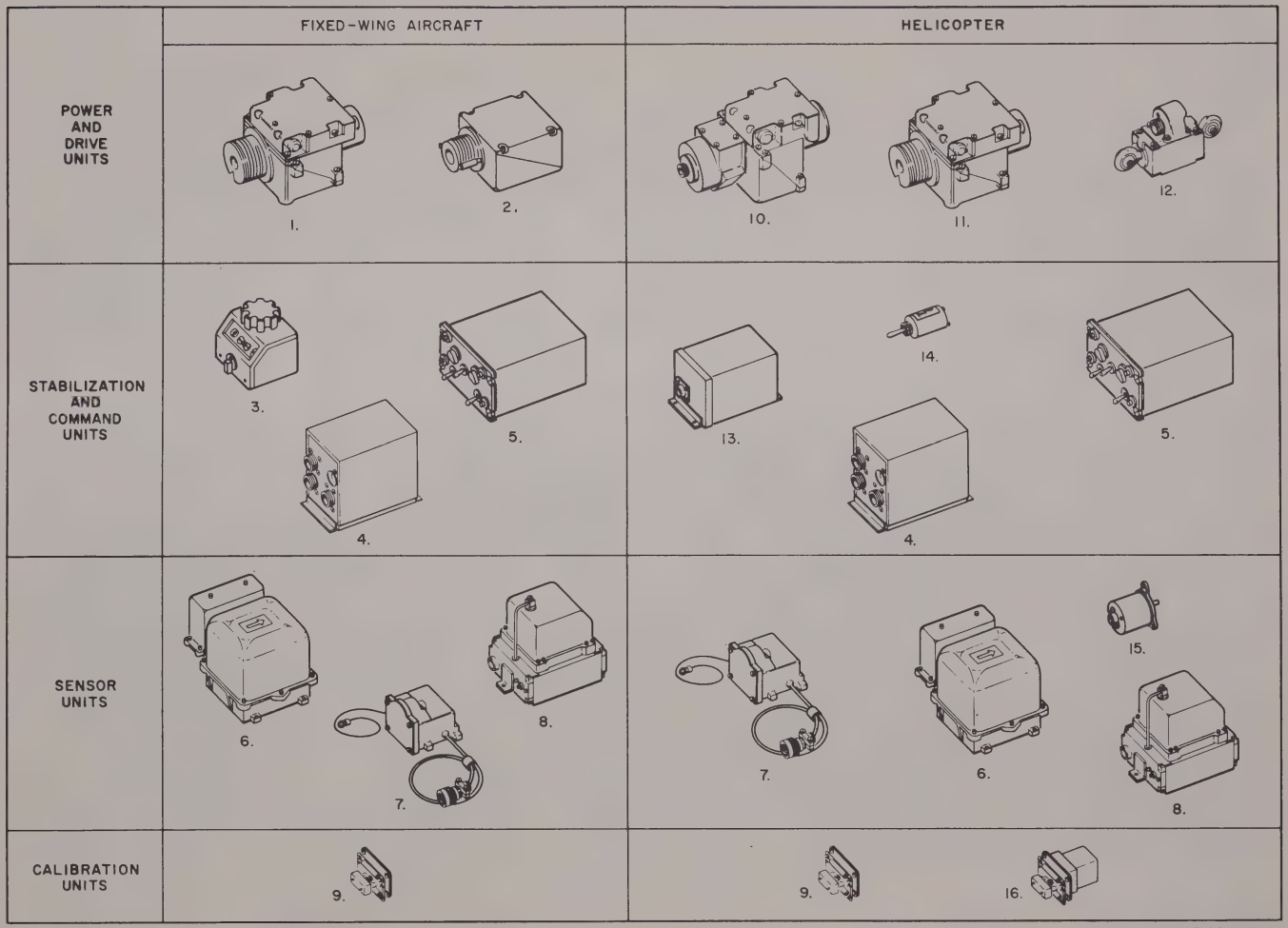

Figure 5. Classification of components.

1 Roll, pitch, or yaw power unit (3)
2 Trim power unit (1)
3 Flight controller (1)
4 Attitude reference control (1)
5 Navigational coupler (1)
6 Vertical gyro (1)
7 Accelerometer (1)
8 Altitude control (1)
9 Roll, pitch, or yaw calibration card (3); roll, pitch, yaw, or collective pitch calibration card (H) (4)
10 Pitch or roll power unit (H) (2)
11 Yaw power unit (H), collective pitch power unit, or rpm power unit (3)
12 Pitch or roll differential (2)
13 Collective pitch command control (1)
14 Rpm switch (1)
15 Command pickoff (1)
16 Rpm sensor (1)

Figure 5 — Continued.

6. Nomenclature and Common Name

a. Fixed-Wing Components. A list of the nomenclature assignment for the components of Automatic Flight Control System AN/ASW–12(V) used in fixed-wing aircraft is given below. A common name is listed after each item.

Nomenclature	Common name
Actuator, Electro-mechanical, Rotary TG–78/ASW–12(V).	Roll power unit
Actuator, Electro-mechanical, Rotary TG–79/ASW–12(V).	Pitch power unit
Actuator, Electro-mechanical, Rotary TG–80/ASW–12(V).	Yaw power unit
Actuator, Electro-mechanical, Rotary TG–81/ASW–12(V).	Trim power unit
Gyroscope, Displacement CN–601/ASW–12(V).	Vertical gyro
Control, Attitude, Reference C–3108/ASW–12(V).	Attitude reference control
Control, Altitude, Automatic Pilot C–3106/ASW–12(V).	Altitude control
Controller, Flight, Automatic Pilot C–3107/ASW–12(V).	Flight controller
Accelerometer, Aircraft MX–2916/ASW–12(V).	Accelerometer
Coupler, Navigational CU–792/ASW–12(V).	Navigational coupler
Calibration Unit MX–2917/ASW–12(V).	Roll calibration card
Calibration Unit MX–2918/ASW–12(V).	Pitch calibration card
Calibration Unit MX–2919/ASW–12(V).	Yaw calibration card

b. Helicopter Components. A list of common names for the components of the automatic flight control system used in helicopters is given below. Some of the components listed are nomenclatured items used both for fixed-wing aircraft and helicopter applications; some of the components listed are nonnomenclatured items used only for helicopter application. These nonnomenclatured items are given common names to avoid the continuous use of cumbersome descriptive names. The designation (H) in the common names section distinguishes between fixed-wing and helicopter components that would otherwise share the same common name.

Components	Common names
Actuator, electromechanical, rotary, flexible shaft, pitch.	Pitch power unit (H)
Actuator, electromechanical, rotary, flexible shaft, roll.	Roll power unit (H)
Actuator, electromechanical, rotary, yaw.	Yaw power unit (H)
Actuator, electromechanical, rotary, collective pitch.	Collective pitch power unit
Actuator, electromechanical, rotary, rpm.	Rpm power unit
Actuator, mechanical, linear, pitch.	Pitch differential
Actuator, mechanical, linear, roll.	Roll differential
Transducer, rotary motion, rpm	Command pickoff
Gyroscope, Displacement CN–601/ASW–12(V).	Vertical gyro
Control, Attitude, Reference C–3108/ASW–12(V).	Attitude reference control
Control, Altitude, Automatic Pilot C–3106/ASW–12(V).	Altitude control
Accelerometer, Aircraft MX–2916/ASW–12(V).	Accelerometer
Coupler, Navigational CU–792/ASW–12(V).	Navigational coupler
Control, command, collective pitch.	Collective pitch command control
Calibration unit, pitch	Pitch calibration card (H)
Calibration unit, roll	Roll calibration card (H)
Calibration unit, yaw	Yaw calibration card (H)
Calibration unit, collective pitch	Collective pitch calibration card
Network, sensing, rpm	Rpm sensor
Switch, control, rpm	Rpm control switch

7. Description of Automatic Flight Control System

The components of the automatic flight control system are grouped by aircraft type, fixed-wing or helicopter, and the following four functions: power and drive, stabilization and command, sensor, and calibration (fig. 5). In the legend for figure 5, only one unit for each

system component is illustrated and the number shown in parentheses following the component description indicates the quantity of similar units required. The location of components in fixed-wing aircraft is described in *a* below, and for helicopters in *b* below.

a. Fixed-Wing. The power and drive units (1 and 2) are mechanically connected to the aircraft control surfaces. The stabilization, command, and sensor units (3 through 8) are electrically connected to the power and drive units. The calibration units (9) are small modules which plug into the power units. Figure 1 illustrates the typical location of the automatic flight control system components in a fixed-wing aircraft.

b. Helicopter. The power and drive units (10, 11, and 12, fig. 5) and sensor (command pickoff) unit (15) are mechanically connected to the helicopter attitude, collective pitch, and engine throttle controls. The stabilization, command and sensor units (4 through 8 and 13 and 14) are electrically connected to the power and drive units. The calibration units (9 and 16) are small modules which plug into the power units. Figure 2 illustrates the typical location of the automatic flight control system components in a helicopter.

8. Description of Power Units
(fig. 6)

The roll, pitch, and yaw power units (H) for helicopter and fixed-wing and collective pitch power unit (helicopter) are identical except for differences in their gear ratios (instrument train), power train ratios, and their shearpin torques. Output power is transformed and applied by rotary motion of the output drum to the aircraft control surfaces. The roll, pitch, and yaw power units consist of the following major assemblies:

a. Drum and Bracket Assembly. The drum and bracket assembly is a mechanical assembly that contains a mounting base for installation in the aircraft and an output drum for control cable takeup.

b. Servodrive Assembly. The servodrive assembly contains a direct-current (dc) permanent magnet motor (servomotor) which drives a power gear train and an instrument gear train. Four captive screws clamp the servodrive assembly into the drum and bracket assembly.

c. Amplifier Assembly. The amplifier assembly is mounted on top of the servodrive assembly. Power is supplied through the electrical connector at the rear of the amplifier assembly. Transistors are mounted on both sides of the amplifier assembly.

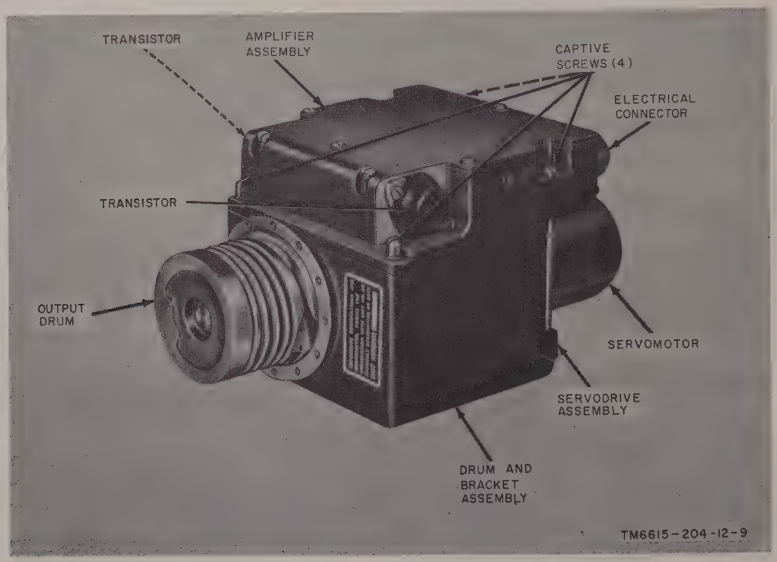

Figure 6. Power unit.

9. Description of Actuator, Electro-mechanical, Rotary TG–81/ASW–12(V) (fig. 7)

The trim power unit output power is applied through the rotary motion of the output drum. The trim power unit consists of the following major assemblies which can be separated by removing the four captive screws.

a. Drum and Bracket Assembly. This assembly is identical with that of the roll, pitch, and yaw power units (drum and bracket assemblies) described in paragraph 8*a*; differing only in their gear ratios (instrument train), power train ratios, and shearpin torques.

b. Servodrive Assembly. Four captive screws bolt the servodrive assembly on top of the drum and bracket assembly. Power is applied through an electrical connector mounted at the rear of the servodrive assembly. Output power is transformed and applied by rotary motion of the output drum.

10. Description of Actuators, Electromechanical, Rotary, Flexible Shaft, Pitch and Roll (fig. 8)

The pitch and roll power units (H) consist of three major assemblies which can be separated by removing the four captive screws.

a. Flexible Shaft and Bracket Assembly. This assembly is identical with that of the roll, pitch, and yaw power units (drum and bracket assemblies) described in paragraph 8*a*; differing only in their gear ratios (instrument train), power train ratios, and shearpin torques. The output drum has been replaced by a flexible shaft adaptor assembly to drive the flexible shaft cable. Output power is applied through the rotary motion of the flexible shaft cable connected to the flexible shaft receptacle (fig. 8). The flexible shaft cable is shown connecting item 4 to 6 and item 5 to 7 in figure 2.

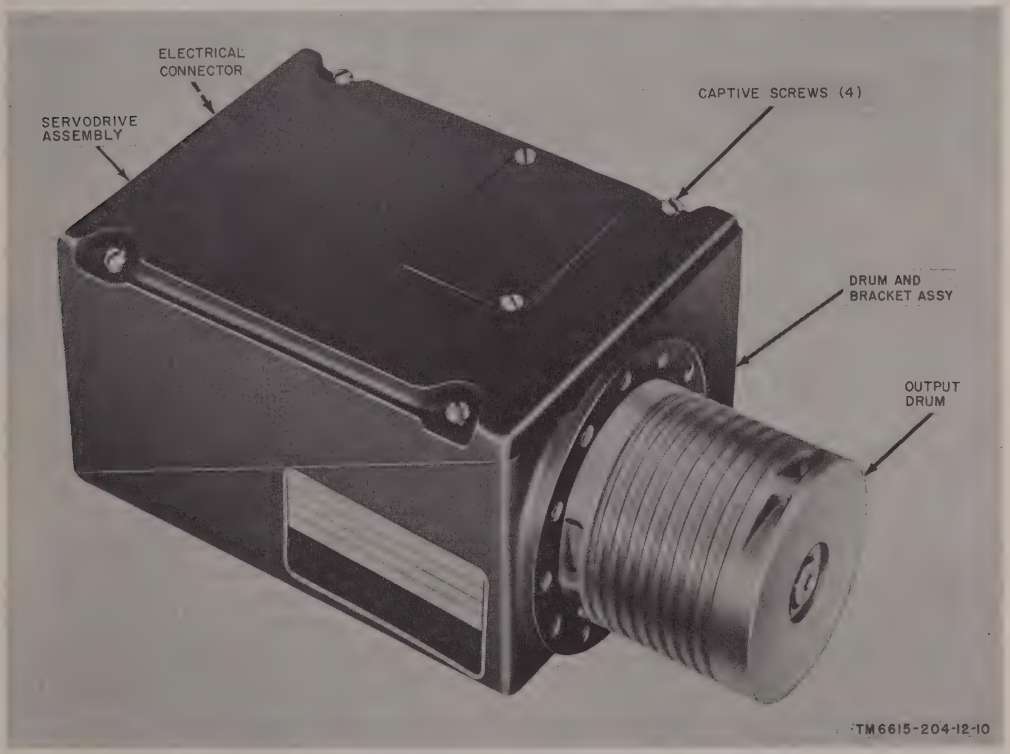

Figure 7. Actuator, Electro-mechanical, Rotary TG–81/ASW–12(V).

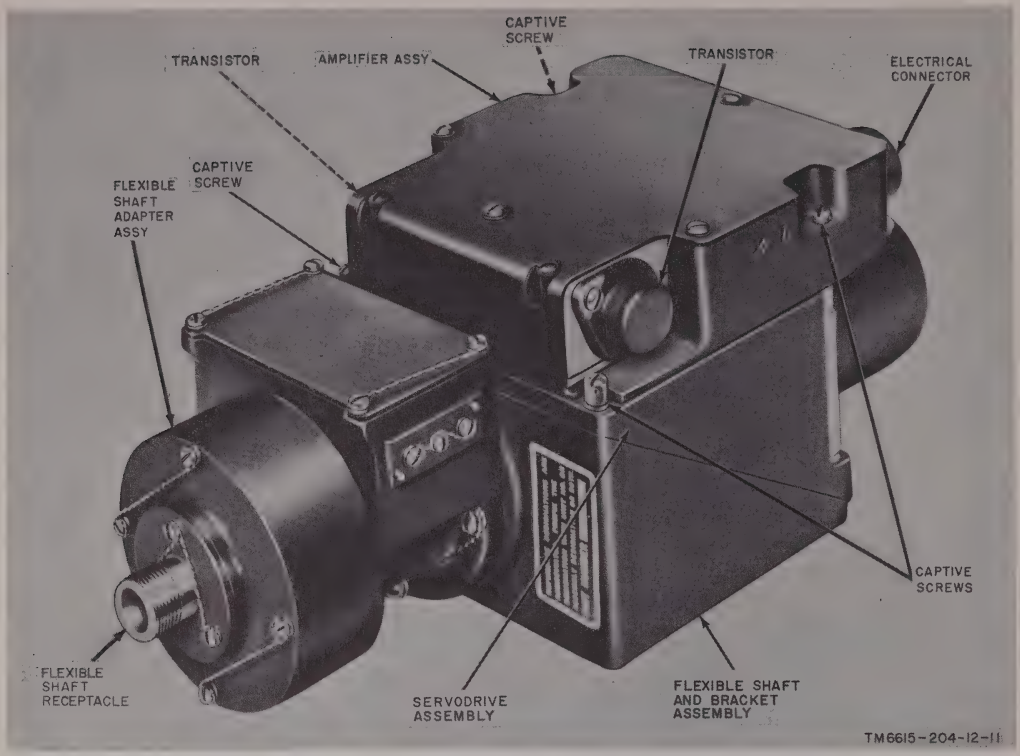

Figure 8. Actuator, electromechanical, rotary, flexible shaft, pitch or roll.

b. Servodrive Assembly. This assembly is identical with that described in paragraph 8*b*.

c. Amplifier Assembly. This assembly is identical with that described in paragraph 8*c*.

11. Description of Actuators, Mechanical, Linear, Pitch and Roll

(fig. 9)

The pitch and roll differentials contain a flexible shaft receptacle on top of the unit. Two rod end bearings are located at each end. Rotary motion of the flexible shaft cable (para 10*a*) is converted to a linear motion change between the rod end bearings.

12. Description of Coupler, Navigational CU–792/ASW–12(V)

(fig. 10)

The navigational coupler consists of a front panel assembly, chassis assembly, and a chassis assembly cover. Operational controls are located on the front panel assembly. Two electrical connectors are mounted at the rear of the unit. The chassis assembly cover can be removed by unfastening the four quick-disconnect fasteners. The front panel assembly consists of five panel indicator lamps (edge-lighted) with the necessary switching controls to allow the pilot to select the desired mode of operation.

13. Description of Control, Attitude, Reference C–3108/ASW–12(V)

(fig. 11)

The attitude reference control front panel contains electrical connectors J1, J2, and J3, and an elapsed time indicator. The elapsed time indicator records the total time power has been applied to the attitude reference control. It thereby furnishes a reference for determining the operating time of the automatic flight control system components. The mounting holes, front and rear, are an integral part of the front and rear panels.

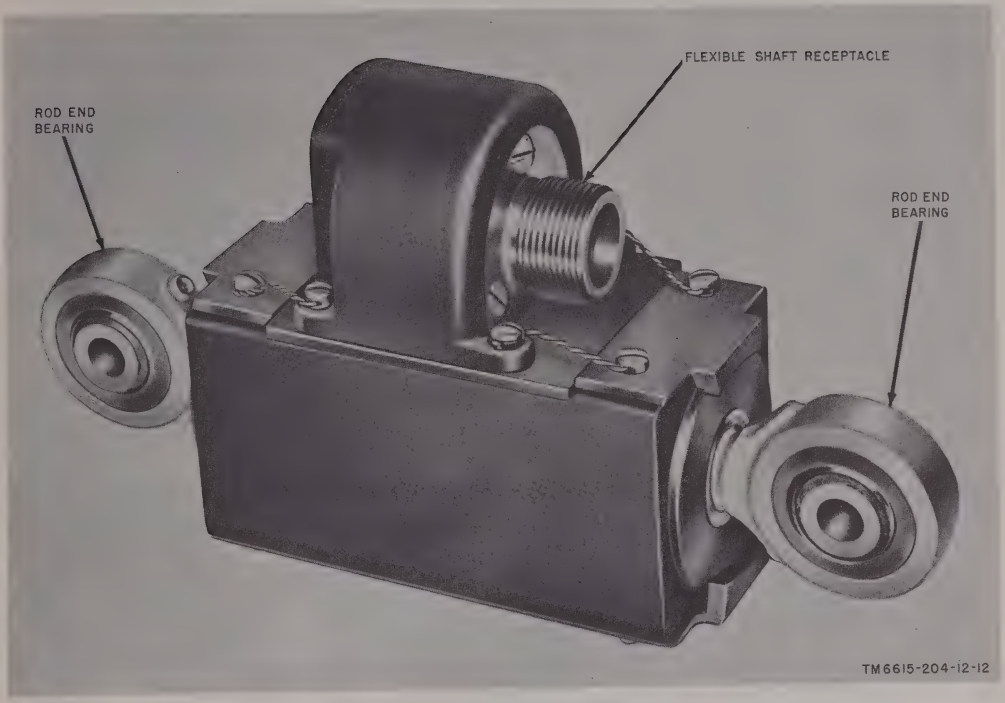

Figure 9. Actuator, mechanical, linear, pitch or roll.

14. Description of Controller, Flight, Automatic Pilot C–3107/ASW–12(V)

(fig. 12)

The top horizontal surface of the flight controller contains a pitch (beep switch)-roll control (TURN knob). The knob can be rotated and moved fore or aft simultaneously. It is spring-loaded in the fore and aft movement so that it will return to the center detent position when released. Located on the front vertical part of the flight controller is a ROLL TRIM control. Three edge-lighted servoeffort indicators are located above the ROLL TRIM control knob. These servoeffort indicators (pitch, roll, and yaw) compare the aircraft's control surface movements (elevator, aileron, and rudder) from a fixed reference (neutral) position for each control axis.

15. Description of Control, Command, Collective Pitch

(fig. 13)

The collective pitch command control contains an electrical connector (J1) mounted on the front panel. Mounting holes are located on the bottom of the front and rear panels of the unit.

16. Description of Switch, Control, Rpm

(fig. 14)

The revolutions-per-minute (rpm) control switch consists of a switch and a four-conductor cable assembly. A bracket, two mounting nuts, and a lockwasher are used in the mounting of the rpm control switch. A typical installation is shown in figure 26. The rpm control switch is of a momentary hold type when actuated, and must be manually held in its operational mode.

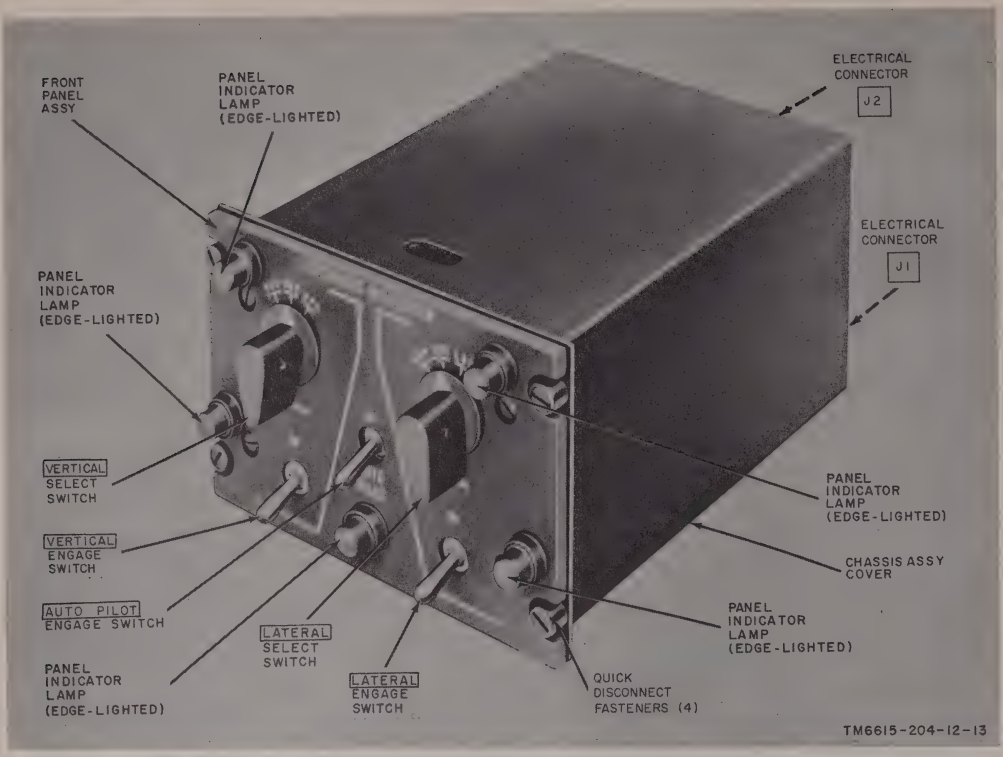

Figure 10. Coupler, Navigational CU–792/ASW–12(V).

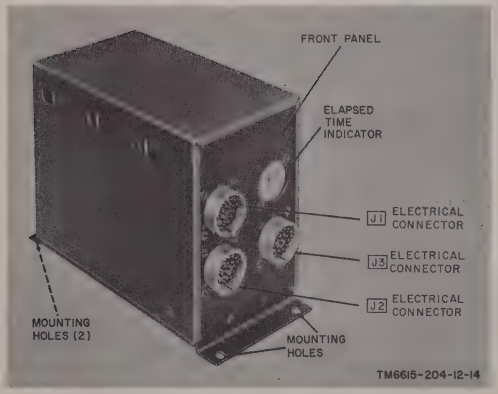

Figure 11. Control, Attitude, Reference C–3108/ASW–12(V).

17. Description of Control, Altitude, Automatic Pilot C–3106/ASW–12(V) (fig. 15)

The altitude control consists of two major assemblies: a pressure-sensitive assembly and an electronic chassis. The pressure-sensitive assembly is mounted on top of the chassis. An electrical connector (J1) and a threaded opening (static pressure input) are provided on the chassis to receive the input power cable and the static pressure input. The front of the unit has a single mounting hole, and the back of the unit has two mounting holes.

18. Description of Accelerometer, Aircraft MX–2916/ASW–12(V) (fig. 16)

The accelerometer has four mounting lugs (two on each side), a six-prong electrical connector and cable assembly, and a bonding cable on the left side. Arrows on the nameplate show the axis of sensitivity to permit mounting for any application.

19. Description of Gyroscope, Displacement CN–601/ASW–12(V) (fig. 17)

The vertical gyro consists of two major as-

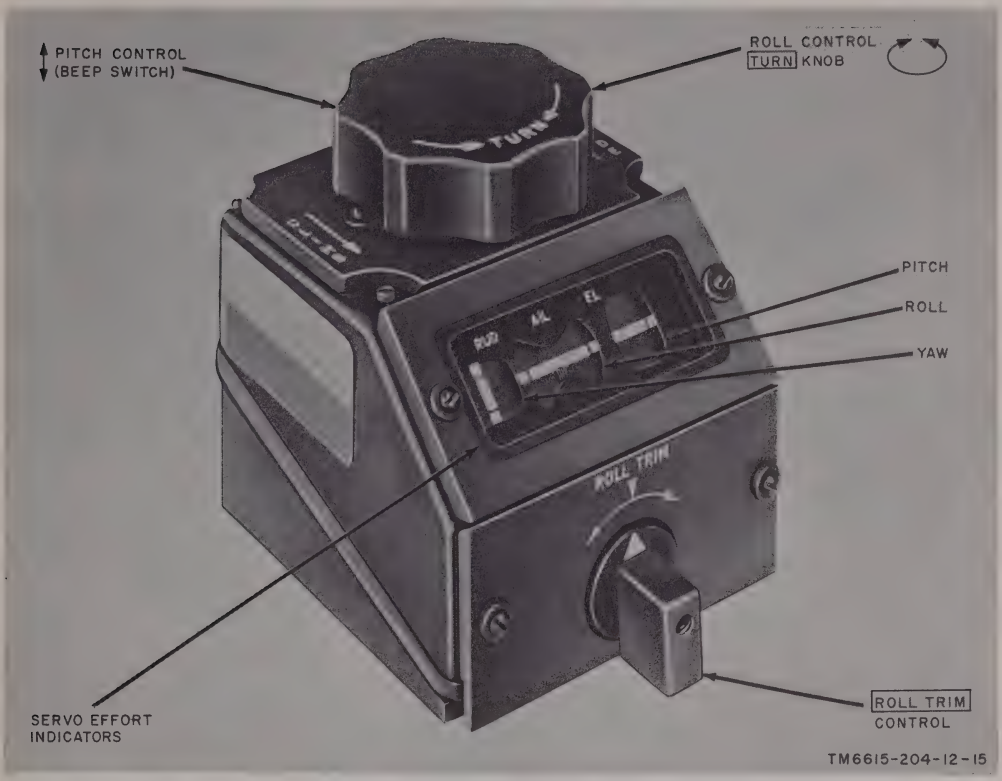

Figure 12. Controller, Flight, Automatic Pilot C–3107/ASW–12(V).

Figure 13. Control, command, collective pitch.

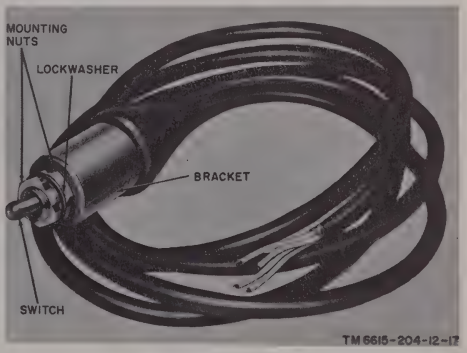

Figure 14. Switch, control, rpm.

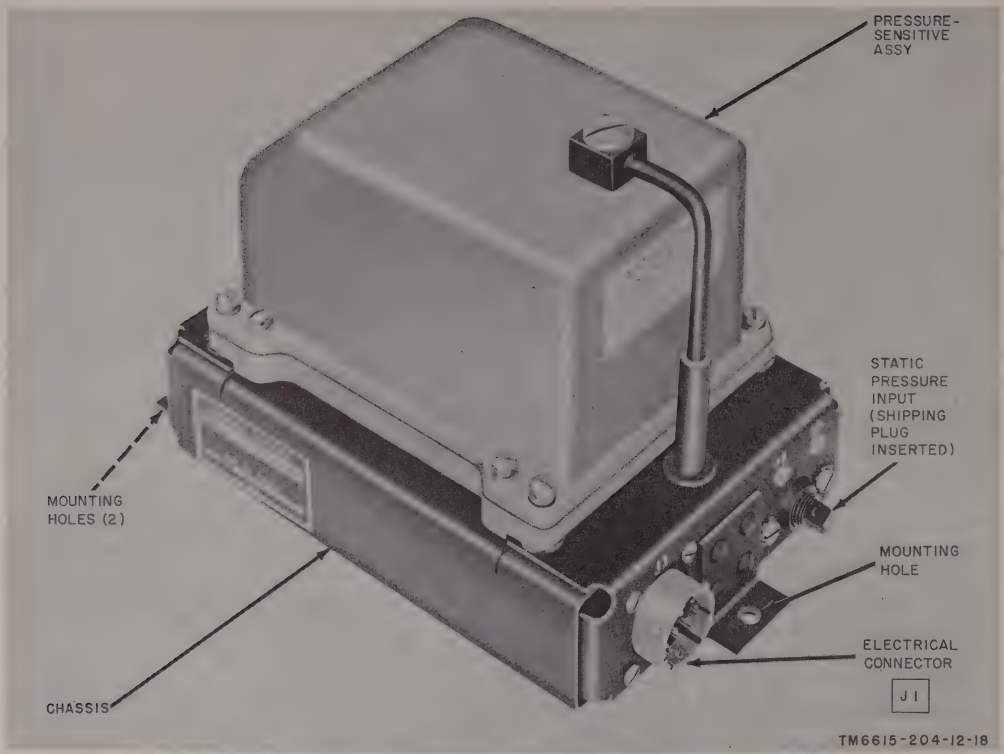

Figure 15. Control, Altitude, Automatic Pilot C–3106/ASW–12(V).

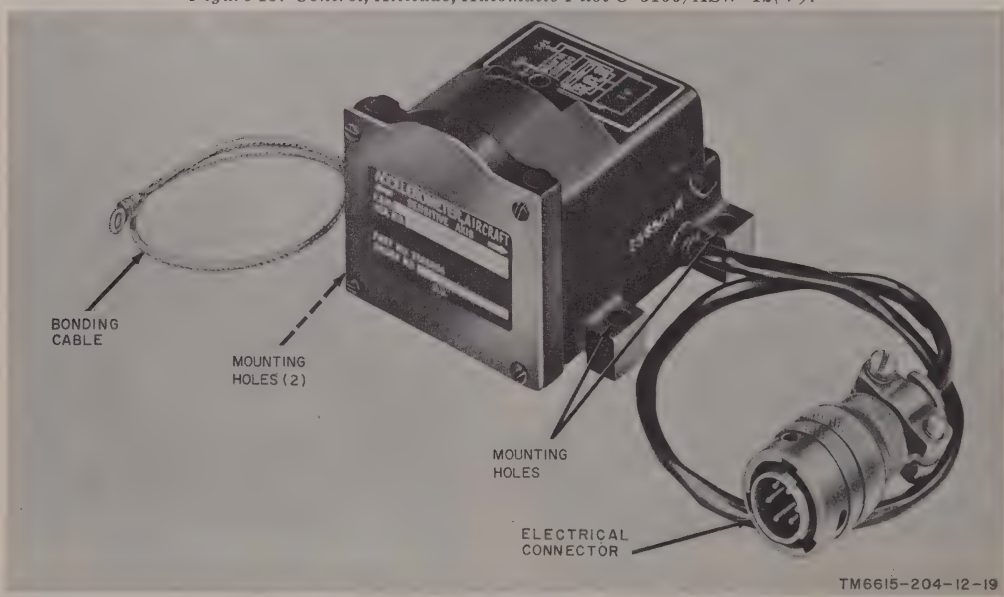

Figure 16. Accelerometer, Aircraft MX–2916/ASW–12(V).

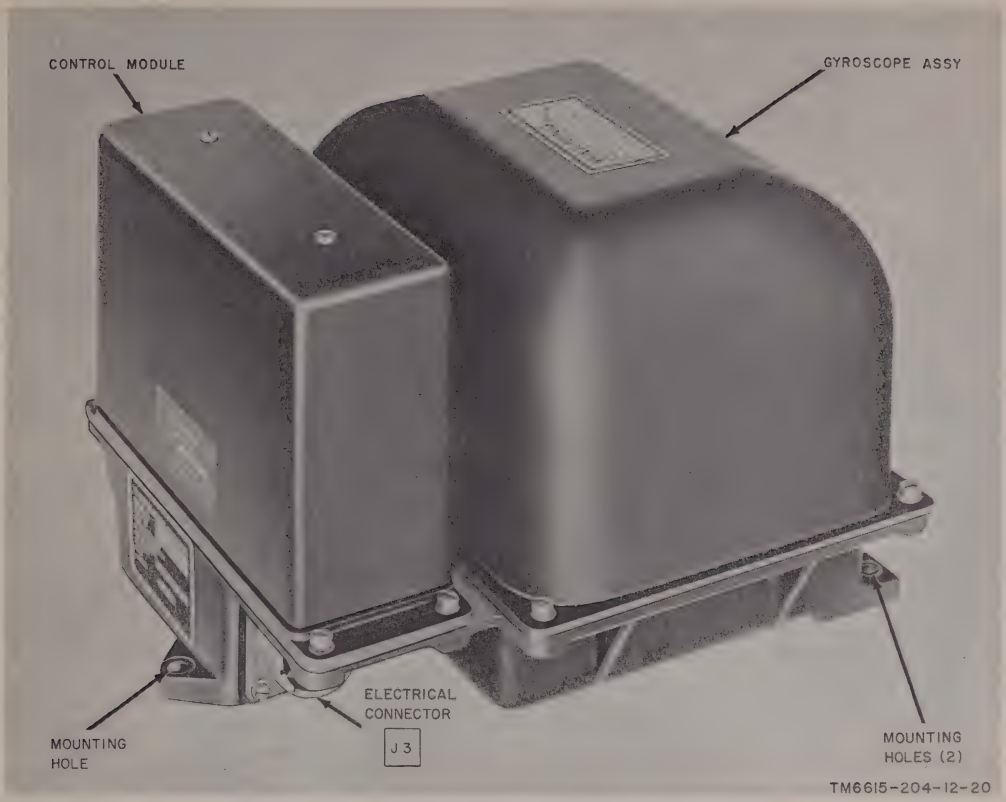

Figure 17. Gyroscope, Displacement CN–601/ASW–12(V).

semblies mounted on a single cast base: the gyroscope assembly and the control module. At the top of the gyroscope assembly, a warning plate contains an arrow indicating the proper mounting position for the unit. An electrical connector (J3) is located underneath the control module. One mounting hole is located at the module end of the base and two more are located at the other end of the base.

20. Description of Transducer, Rotary Motion, Rpm

(fig. 18)

The command pickoff consists of a cylindrical case with three mounting holes located at the drive shaft end. The drive shaft contains a key slot. Test points (J2, J3, and J4) and an electrical connector (J1) are located at the opposite end from the drive shaft.

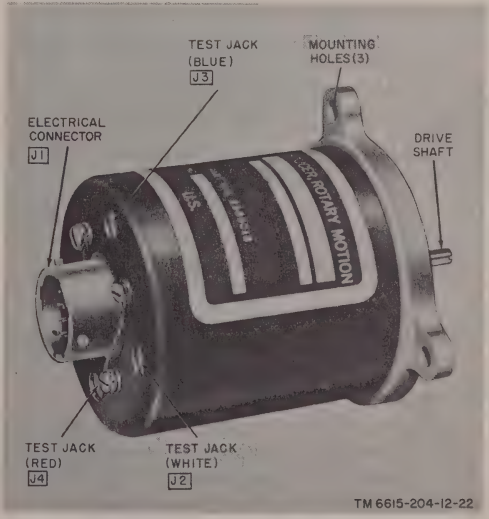

Figure 18. Transducer, rotary motion, rpm.

21. Description of Calibration Unit (fig. 19)

The calibration cards have four mounting holes. On the case of each card is an identifying nameplate (fig. 27). An electrical connector is provided so that cards may be changed without unsoldering connections.

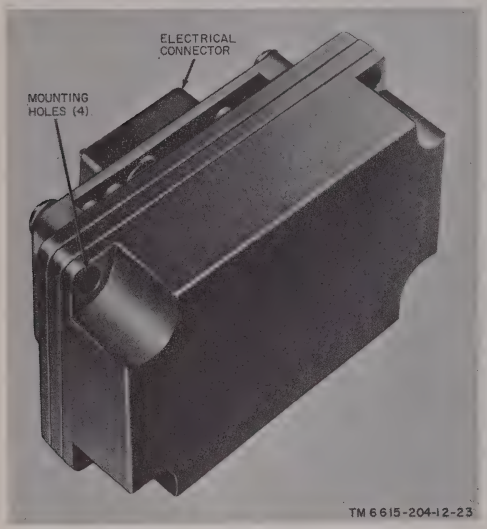

Figure 19. Calibration Unit.

22. Description of Network, Sensor, Rpm (fig. 20)

The rpm sensor is mounted with screws through the four mounting holes. Power is supplied by an electrical connector.

23. Additional Equipment Required

The following items are required to operate the automatic flight control system. These items are supplied as part of the aircraft in which the equipment is installed.

a. Controls.

(1) *The pilot release switch* (fig. 25) actuates the automatic flight control system. It is used to apply power to the attitude engage holding coil within the navigational coupler. The equipment cannot be operated unless this switch is energized.

(2) *The beep switch* (fig. 25) allows the pilot to change the pitch and roll axes of the aircraft. On fixed-wing aircraft, this control is part of the flight controller.

(3) *The magnetic break switch* (fig. 25) allows the pilot to position the flight control to establish a new aircraft attitude.

(4) *The heading lock switch* (fig. 26) is used to reengage the automatic flight control system hold function, after the pilot has initiated a turn.

b. Indicators. Two lights are usually provided to aid the pilot in determining the operational status of the automatic flight control system. These lights are mounted in the cockpit of the aircraft.

(1) *The standby light* is amber and is used to indicate that the automatic flight control system is ready to be engaged, after power has been applied to the equipment. It also indicates that the equipment has become disengaged or that command of the aircraft has been taken over by the pilot.

(2) *The YAW SAS light* is green and is used (helicopters only) to indicate the loss of the heading hold function.

c. Cables and Circuit Breakers. The cables necessary to make the equipment operational are supplied as part of the aircraft. Circuit breakers, as applicable to the installation and the aircraft, are also provided.

Section III. SYSTEM APPLICATION, FIXED-WING AIRCRAFT

24. General

The groupings of components as they are used in the fixed-wing and helicopter systems were presented in paragraph 7. This section describes the flow of signals in the two systems and the functions which are accomplished by this signal flow. The signal flow in the fixed-wing system is divided into control channels for each of the three flight axes: pitch, roll, and yaw (fig. 21). Each of the control channels is expanded to indicate the use of the sensor units, the stabilization and command

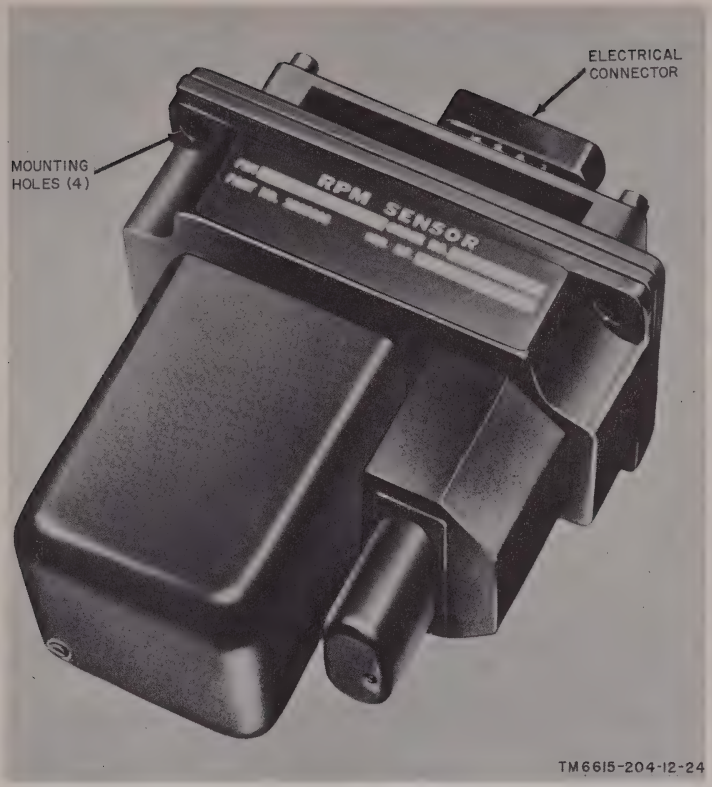

Figure 20. Network, sensor, rpm.

units, and the power and drive units (fig. 5). The system is started by engaging the power units to the aircraft control system. Engagement consists of operating (electrically) clutches which connect the power units to the aircraft control system. When the system is engaged, the flow of signal from the sensor units, stabilization and command units, and navigation aids, afford attitude and heading stabilization, altitude control, and/or automatic path guidance, depending upon the operating mode selected. While each control channel is electrically independent from every other control channel on a signal basis, the operation of the roll control channel for command of banked turns is coordinated with the yaw control channel to insure that the turn will be a coordinated turn. Operation of the individual control channels is described in paragraphs 25, 26, and 27.

25. Pitch Axis Control Channel
(fig. 21)

a. The fixed-wing pitch axis control channel functions to control the pitch attitude of the aircraft. Signals from five sources may be fed to the pitch power unit which positions the elevator control:

(1) The vertical gyro signal measures the pitch attitude of the aircraft.
(2) The flight controller signal indicates that a change in attitude is being commanded by the pilot.
(3) The altitude control signal measures the change in barometric altitude from a selected altitude.
(4) The radar altimeter signal measures the change in radar altitude from a selected altitude.
(5) The glide path signal measures the

deviation in altitude between the path of the aircraft and the approach glide path.

b. The vertical gyro signal and flight controller signal are used for attitude stabilization and command. The vertical gyro signal feeds to the pitch control channel of the attitude reference control where it is compared with a reference or selected attitude. The flight controller signal, which is also fed to the attitude reference control, changes the reference attitude at a fixed rate, in a noseup or nosedown direction depending on whether the beep switch knob is moved forward or rearward. Differences which exist between the reference attitude selected by the pilot and the actual pitch attitude as sensed by the vertical gyro are then fed to the pitch power unit which positions the elevator to null the difference. Thus, the two signals obtained from the vertical gyro and from the flight controller function to maintain the aircraft at a desired pitch attitude.

c. Alternate signals can be injected into the pitch control channel to maintain a desired altitude through command of pitch attitude. The altitude control signal is introduced when the barometric altitude (BAR) control function is selected and engaged at the navigational coupler. This signal is fed from the altitude control through the navigational coupler to the pitch control channel of attitude reference control, to command changes in pitch attitude reference to maintain a constant barometric altitude. In a similar manner, glide path (APP) and radar altimeter (RAD) signals may be used to control approach or radar altitude. Through a switching system incorporated in the navigational coupler, it is not possible to operate more than one mode of altitude control at a time. To avoid conflicting commands to the attitude reference control, the flight controller command mode is deactivated when the VERTICAL engage switch is at ON.

26. Roll Axis Control Channel
(fig. 21)

a. The fixed-wing roll axis control channel functions to control the roll attitude of the aircraft. Signals from six sources may be fed to the roll power unit which positions the aileron:

(1) The vertical gyro signal measures the roll attitude of the aircraft.
(2) The flight controller signals indicate that a change in attitude is being commanded by the pilot. Two signals are available within the flight controller: a turn knob signal for commanding banked turns and a trim knob signal for trimming the attitude during straight flight without introducing heading changes. The pitch control channel operates in conjunction with the turn knob signal to provide automatically coordinated turns.
(3) The very high frequency omnidirectional radio range (VOR) signal measures the difference between a selected radial path to the station and the actual path of the aircraft.
(4) The instrument landing approach system (ILS) signal measures the deviation of the aircraft from the center of the localizer beam.
(5) The Doppler navigation signal measures the difference between a preset path and the actual path of the aircraft.
(6) The heading select signal measures the difference between a selected magnetic heading and the actual magnetic heading of the aircraft.

b. The vertical gyro signal and flight controller signals are used for attitude stabilization and command. The vertical gyro signal is fed to the roll axis of the attitude reference control where it is compared with a reference or selected attitude. The flight controller signal from the TURN knob is also fed to the attitude reference control to change the reference attitude proportional to the rotation of the knob, roll right or roll left, depending on the direction in which the TURN knob is moved. When the knob is centered, the attitude reference will be set for level flight. Since the system is interlocked to engage only with the TURN knob centered, the aircraft is automatically commanded to level attitude upon engagement. After engagement, the aircraft will be maintained in a level attitude. If any differences develop between the reference level attitude and the actual roll attitude, signals are fed to the roll power unit which positions the

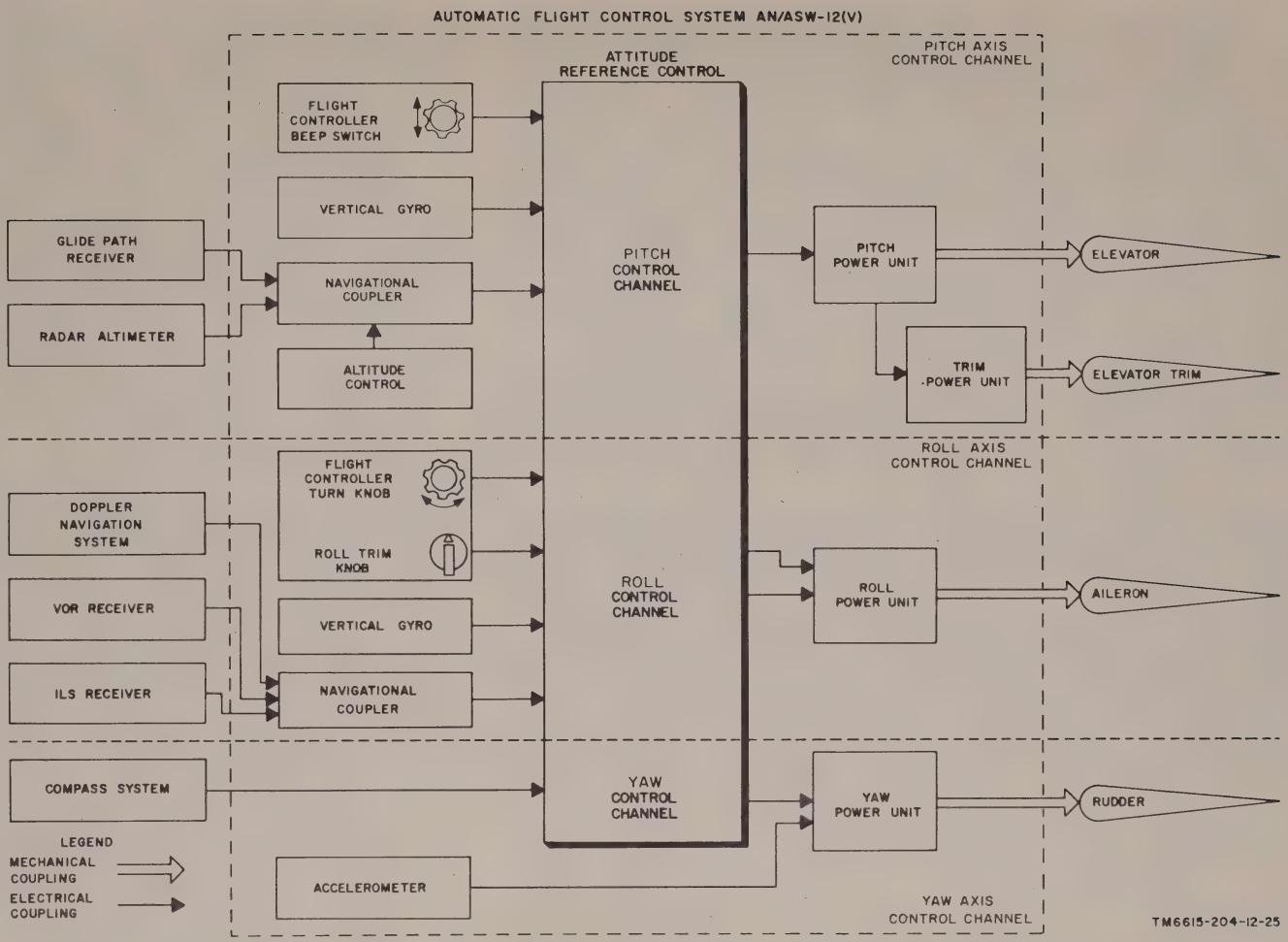

Figure 21. Automatic flight control system, fixed-wing, block diagram.

aileron to null the difference. The signal from the ROLL TRIM control in the flight controller is used to make small trim changes in roll attitude without heading change. Thus, the signals obtained from the vertical gyro and from the flight controller function to maintain the aircraft at a desired roll attitude. Alternate signals can be injected into the roll control channel to maintain selected path orientations through command of roll attitude. The VOR signal is introduced when the VOR function is selected and engaged at the navigational coupler. This signal is fed from the VOR receiver through the navigational coupler to the attitude reference control roll control channel to command changes in roll attitude reference, to maintain the aircraft on the selected path of navigation. In a similar manner, instrument landing approach system and Doppler navigation signals may be used to control the selected paths of navigation consistent with these navigation aids. Through a switching system incorporated in the navigational coupler, it is not possible to operate more than one mode of path control at a time. To avoid conflicting commands to the attitude reference control, the use of the flight controller TURN knob will automatically disengage any path mode which may have been previously engaged; that is, pilot command of roll attitude takes precedence over the automatic path control mode.

27. Yaw Axis Control Channel
(fig. 21)

a. The fixed-wing yaw axis control channel maintains constant heading in level flight and provides turn coordination in banked flight. Signals from two sources may be fed into the yaw power unit which positions the rudder control:

(1) The compass system signal measures the heading of the aircraft.
(2) The accelerometer signal measures the side acceleration of the aircraft.

b. The compass system signal is used for heading stabilization. It feeds to the attitude reference control yaw control channel where it is compared with a reference heading. Initially, before the system is engaged, the heading reference is automatically *aligned* with the prevailing *compass heading*. When the automatic flight control system is engaged, differences which exist between the reference heading and the actual heading are then fed to the yaw power unit which positions the rudder to null the difference. When a roll attitude is commanded through the TURN knob or when the lateral channel of the navigational coupler is engaged (para 26*b*) the heading reference is again automatically aligned with the actual changing heading. The accelerometer signal is fed to the yaw power unit to minimize the side acceleration of the aircraft through rudder command.

Section IV. SYSTEM APPLICATION, HELICOPTER

28. General

The signal flow in the helicopter system is divided into control channels for controlling each of the three flight axes, and the collective pitch control channel (altitude) and engine rpm (fig. 22). Each of the control channels is expanded to indicate the use of the sensor units, the stabilization units, the command units, and the power and drive units (fig. 5). The system is started by engaging the power units to the aircraft control system. Engagement consists of operating (electrically) clutches which connect the power units to the aircraft control system. When the system is engaged, the flow of signal from the sensor units, stabilization and command units, and navigation aids, affords attitude and heading stabilization, engine rpm stabilization, altitude control, and or automatic path guidance, depending on which modes are selected. While each control channel is electrically independent from every other control channel on a signal basis, the operation of the roll control channel for command of banked turns is coordinated with the yaw control channel to insure that the turn will be coordinated. Operation of the individual control channels is described in paragraphs 29 through 33.

29. Pitch Axis Control Channel

a. The helicopter pitch axis control channel (fig. 22) functions to control the pitch attitude

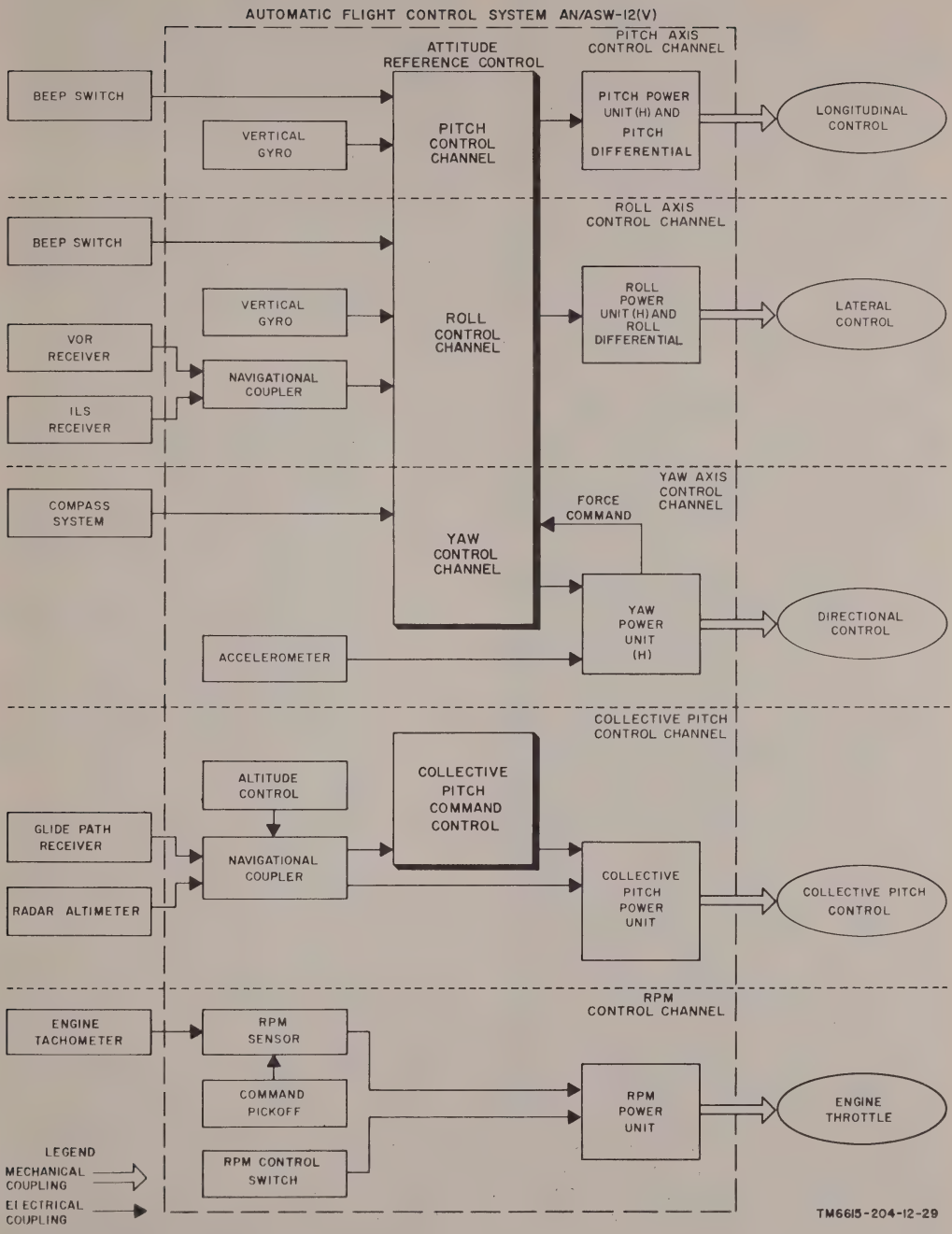

Figure 22. Automatic flight control system, helicopter block diagram.

of the aircraft. Two different signals are fed through the roll control channel to the pitch power unit (H) which position the longitudinal control of the helicopter:

(1) The vertical gyro signal measures the pitch attitude of the aircraft.

(2) The beep switch signal indicates that a change in attitude is being commanded by the pilot.

b. The vertical gyro signal and the beep switch signal are used for attitude stabilization and command. The vertical gyro signal feeds to the pitch control channel of the attitude reference control where it is compared with a reference or selected attitude. The beep switch signal is obtained from a four-way thumb switch (beep switch) located on the control stick. The beep signal is fed to the pitch control channel of the attitude reference control and changes the reference attitude at a fixed rate, in a noseup or nosedown direction, depending on the direction in which the beep switch is moved.

c. Differences which exist between the reference attitude selected by the pilot and the actual pitch attitude are then fed to the pitch power unit (H), which positions the longitudinal controls to continuously null the difference. The pitch power unit (H) positions the longitudinal controls through the pitch differential. The two units are coupled by a length of flexible shaft (fig. 2, items 4 to 6 and 5 to 7) and the pilot input end of the pitch differential is restrained by a flight control centering spring. Motions transmitted through the flexible shaft will cause adjustments in longitudinal control without moving the pilot's control stick.

d. Two other operating characteristics are embodied in the pitch control channel associated with centering of the pitch power unit (H). The action takes place in the mechanical coupling between the pitch power unit (H) and the longitudinal control. With the system disengaged, a centering spring located in the pitch differential (fig. 29) automatically keeps the pitch differential at its centered or neutral position. With the system engaged, a signal alignment system (operated whenever the aircraft magnetic brake switch is operated) commands the pitch power unit (H) to drive the pitch differential to its neutral position. This signal alignment occurs automatically in the attitude reference control. The results of this operation are identical with the action of the pitch differential centering spring. When the system is disengaged, the pitch differential is centered. Once the neutral position has been reached, the aircraft will be maintained at its prevailing attitude through the pitch attitude stabilization mode.

30. Roll Axis Control Channel

a. The helicopter roll axis control channel (fig. 22) functions to control the roll attitude of the aircraft. Signals from six sources may be fed through the yaw control channel to the roll power unit (H) which positions the lateral control:

(1) The vertical gyro signal measures the roll attitude of the aircraft.

(2) The beep switch signal indicates that a change in attitude is being commanded by the pilot.

(3) The VOR signal measures the difference between the selected radial path to the station and the actual path of the aircraft.

(4) The ILS signal measures the deviation of the aircraft from the center of the localizer beam.

(5) The Doppler navigation (NAV) signal (not shown), feeds into the navigational coupler and measures the difference between a preset path and the actual path of the aircraft.

(6) The heading select signal (not shown), feeds into the navigational coupler and measures the difference between a selected magnetic heading and the actual magnetic heading of the aircraft.

b. The vertical gyro signal and the beep switch signal are used for attitude stabilization and command. The vertical gyro signal feeds to the roll control channel of the attitude reference control where it is compared with a reference or selected attitude. The beep switch signal is obtained from a four-way thumb switch (beep switch) located on the flight control stick as shown in figure 25. The beep signal is fed to the roll control channel of the attitude reference control and changes the reference attitude at a fixed rate, right roll or left

roll, depending on the direction in which the beep switch is moved.

c. Differences which exist between the reference selected by the pilot and the actual roll attitude are then fed to the roll power unit (H) which positions the lateral controls to continuously null the difference. The roll power unit (H) positions the lateral controls through a roll differential. The two units are coupled by a length of flexible shaft. The pilot input end of the roll differential is restrained by the flight control centering spring. Motions transmitted through the flexible shaft will cause adjustments in lateral control without moving the pilot's control stick.

d. Two other operating characteristics are embodied in the roll control channel associated with centering of the roll differential. With the system disengaged, a centering spring located in the roll power unit (H) automatically keeps the roll differential at its centered or neutral position. With the system engaged, a signal alignment system is operated whenever the aircraft magnetic brake switch (fig. 25) is operated. This signal alignment, which occurs automatically in the attitude reference control, commands the roll power unit (H) to drive the roll differential to its neutral position. The results of this operation are identical with the action of the roll power unit (H) centering spring. When the system is disengaged, the roll differential is centered.

e. Alternate signals may be injected into the roll control system to maintain preferred path orientation through command of roll attitude. The VOR receiver signal is introduced when the VOR function is selected and engaged (in the navigational coupler). This signal is fed through the navigational coupler and the attitude reference control to command changes in the roll attitude reference, in this case to maintain the aircraft on the selected path of navigation. In a similar manner, the instrument landing approach system, Doppler navigation, and heading select signals may be used to control the selected paths of navigation consistent with these navigational aids.

Note. Through a switching system incorporated in the navigational coupler, it is not possible to operate more than one mode of path control at a time. To avoid conflicting commands to the attitude reference control, the roll beep switch is deactivated when any of the path control modes have been selected.

31. Yaw Axis Control Channel
(fig. 22)

a. The helicopter yaw axis control channel functions to maintain constant heading in level flight and to provide automatic turn coordination in banked flight. The pilot is able also to command flat turns by applying force to the helicopter rudder (antitorque) pedals. Signals from three sources may be fed through the yaw control channel to the yaw power unit (H) which position the helicopter directional control:

(1) The compass system signal measures the heading of the aircraft.
(2) The accelerometer signal measures the side acceleration of the aircraft.
(3) The yaw force command signal measures pilot-applied force to the pedals.

b. The compass system signal is used for heading stabilization. It feeds to the yaw control channel of the attitude reference control where it is compared with a reference heading. Before the system is engaged, the heading reference is automatically aligned with the prevailing compass heading. Differences which exist between the reference heading and the actual heading after the system is engaged, are fed to the yaw power unit (H) which positions the directional control to null the difference. When a roll attitude is commanded through the roll control channel or when the navigational coupler is engaged (para 30*b*) the heading reference from the compass system is automatically aligned with the actual heading and the accelerometer signal is fed to the yaw power unit (H) to minimize the side acceleration of the aircraft through the operation of the directional controls. When forces are applied to the pilot's pedals, a voltage is generated across the motor in the yaw power unit (H) to resist the applied forces. This voltage is fed to the yaw control channel of the attitude reference control to change the heading reference at a rate which is proportional to the signal. Therefore, the yaw force command system permits flat turn heading changes to be made at a rate of change which is proportional to the force applied by the pilot.

32. Collective Pitch Control Channel
(fig. 22)

a. The helicopter collective pitch control

channel functions to maintain a desired altitude. Signals from three different sources may be fed to the collective pitch power unit which positions the collective pitch control:

(1) The altitude control signal measures the change in barometric altitude from a selected altitude.
(2) The radar altimeter signal measures the change in radar altitude from a selected altitude.
(3) The glide path signal measures the deviation in altitude between the path of the aircraft and the approach glide path.

b. The altitude control signal is introduced when the barometric altitude (BAR) control function is selected and engaged (in the navigational coupler). This signal is fed through the navigational coupler to the collective pitch power unit which controls collective pitch of the helicopter. Consequently, the collective pitch control maintains the altitude control signal at null, thereby maintaining the aircraft at a fixed barometric altitude. In a similar manner, glide path (APP) and radar altimeter (RAD) signals may be used to control approach or radar altitude. Through a switching system incorporated in the navigational coupler, it is not possible to operate more than one mode of altitude control at a time. An interlock function allows the pilot to disengage the collective pitch control channel by overpowering the collective pitch control. When a predetermined force level is reached during the overpowering action, the VERTICAL engage switch automatically disengages. This force level is sensed by a relay which measures the collective pitch power unit voltage and operates to disengage the VERTICAL engage switch.

33. Rpm Control Channel

(fig. 22)

The helicopter rpm control channel functions to maintain constant engine speed. The engine tachometer signal is fed through an rpm sensor and then to the rpm power unit, which positions the engine throttle. The rpm control channel contains no command functions; therefore, the pilot must establish a desired engine speed with the rpm control channel disengaged, then engage the rpm control channel to maintain this engine speed automatically. A signal alignment system synchronizes the rpm control to the prevailing engine speed when the system is disengaged. A second signal from the command pickoff is also introduced to the rpm sensor. The command pickoff is connected to the collective pitch control stick and is therefore capable of measuring motions of the stick. The signal is used to compensate for collective pitch stick motions in helicopters where this compensation may be required. An interlock function allows the pilot to disengage the rpm control channel by overpowering the throttle control. When a predetermined force level is reached during the overpowering action, the rpm control switch automatically disengages. This force level is sensed by a relay which measures the rpm unit motor voltage and operates to disengage the rpm control switch.

CHAPTER 2

OPERATING INSTRUCTIONS, FIXED-WING

Section I. OPERATOR'S CONTROLS AND INDICATORS

Note. This section describes, locates, and illustrates the various controls and indicators used by the pilot.

34. Navigational Coupler
(fig. 23)

The controls and their functions are listed in the following chart:

Control or indicator	Function
AUTO PILOT engage switch (attitude).	Magnetic hold switch. Engages attitude stabilization.
VERTICAL engage switch.	Magnetic hold switch. Engages altitude control channel.
LATERAL engage switch.	Magnetic hold switch. Engages lateral control channel.
VERTICAL select switch.	Selects mode of vertical operation. BAR—altitude is controlled by a referenced barometric pressure. RAD—altitude is controlled by the radar altimeter. APP—altitude is controlled by the glide path receiver.
LATERAL select switch.	Selects mode of lateral operation. NAV—provides automatic lateral control for the aircraft to a ground path. Preset by a Doppler navigational system. VOR—provides automatic lateral control for the aircraft to fly the VHF omnirange navigation signal. LOC—provides automatic lateral control for the aircraft to fly ILS localizer beam. HDG—provides automatic lateral control for the aircraft to a selected magnetic compass heading.
Panel indicator lamps.	Illuminates front panel.

35. Flight Controller
(fig. 24)

The controls and their functions are listed in the following table:

Control or indicator	Function
Roll control (TURN knob).	Detent switch (interlock). Removes power from steering engage control channel. Prevents system engagement unless TURN knob is in detent. Roll control (TURN knob)—adjusts roll control channel to change bank angle proportional to knob rotation with heading change. Pitch control (beep switch)—furnishes signal to change pitch attitude.
ROLL TRIM control.	Adjusts roll attitude without heading change.
Servoeffort indicator.	Shows the position of the pitch, roll, and yaw control surfaces. RUD—shows servoeffort applied to the rudder. AIL—shows servoeffort applied to the aileron. EL—shows servoeffort applied to the elevator.

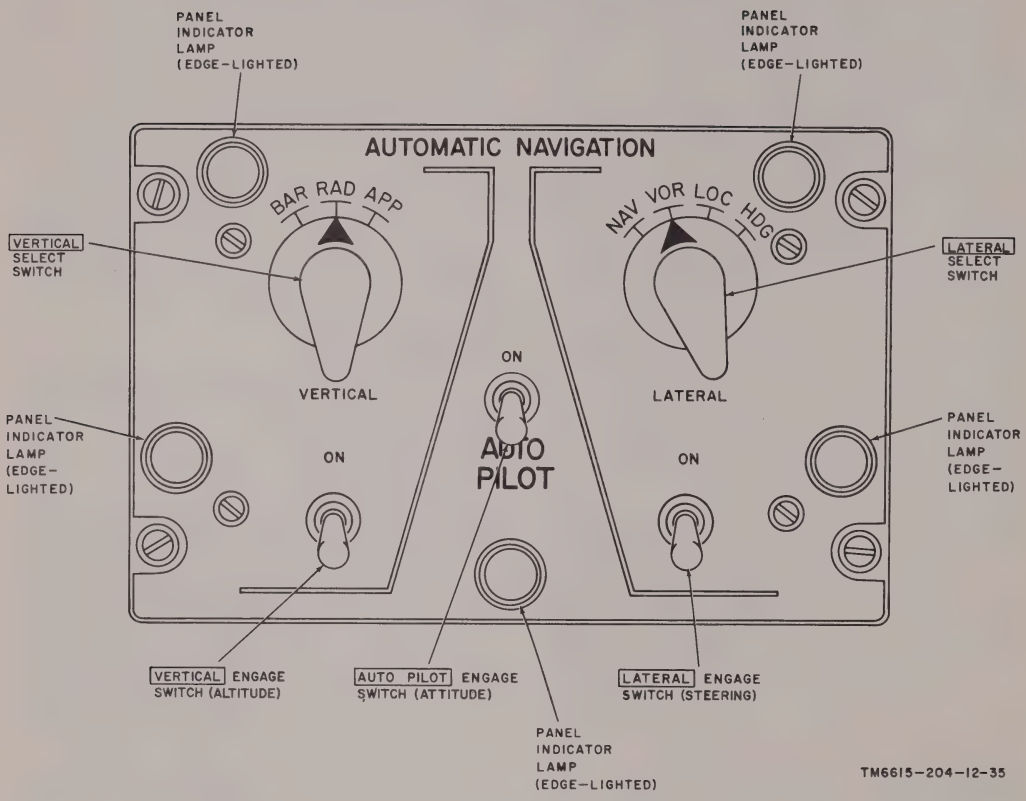

Figure 23. Navigational coupler, control panel.

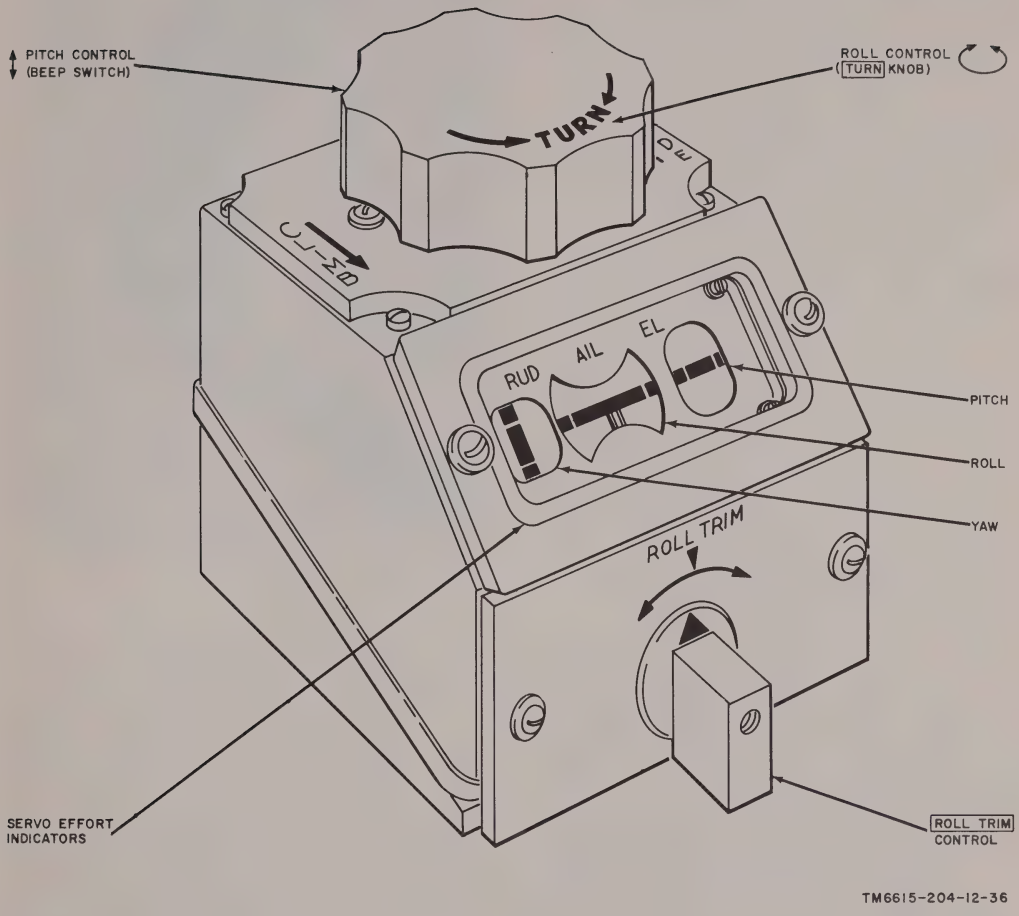

Figure 24. Flight controller, control panel.

36. Fixed-wing Controls

The controls listed below are not supplied as part of the automatic flight control system but are supplied as part of the fixed-wing aircraft in which the automatic flight control system is installed.

Control or indicator	Function & Location
Pilot release switch (fig. 25).	Flight control stick location, provides quick disconnect of system by removing power from the automatic flight control system engage holding coil (para 23*a*).
Standby light.	Installation hardware (para 23*b*). After system power is applied, the steady amber light will denote that the automatic flight control system is ready to be engaged. After the automatic flight control system has been initially engaged, the amber light denotes that the autopilot system has become disengaged either by pilot operation or by power failure.

Note. The YAW SAS light is used in helicopters only.

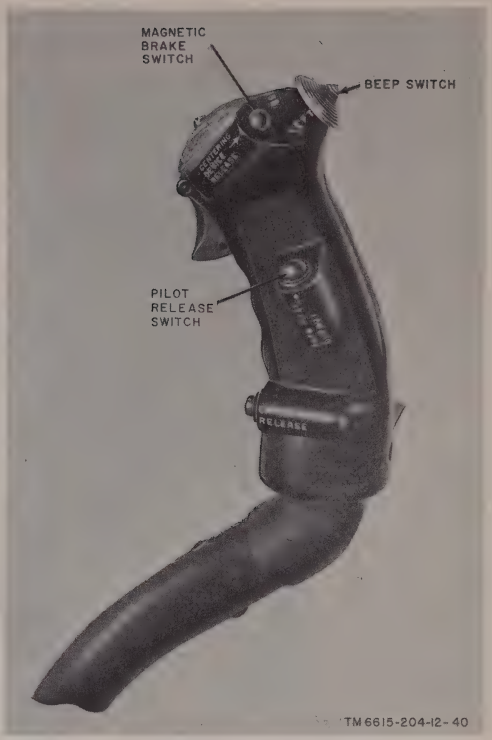

Figure 25. Pilot release and beep switch, typical location.

Section II. OPERATION UNDER USUAL CONDITIONS (FIXED-WING)

37. Types of Operation (Fixed-Wing)

a. The various types of operation available when using the automatic flight control system are listed below.

(1) *Heading select (HDG).* The heading select mode provides automatic lateral control for the aircraft to a selected magnetic compass heading.

(2) *Navigation (NAV).* The navigation mode provides lateral control of the aircraft to a ground path preset into a Doppler navigation set similar to Navigation Set, Radar AN/APN–129(V).

(3) *Localizer (LOC).* The localizer mode provides lateral control of the aircraft to automatically fly the instrument landing approach system localizer beam.

(4) *Very High Frequency Omnidirectional Radio Range (VOR).* The VOR mode provides lateral control of the aircraft to automatically fly a preselected radial of any very high frequency omnidirectional radio range station.

(5) *Barometric altitude (BAR).* The barometric altitude mode provides vertical control for the aircraft to maintain a constant barometric pressure altitude.

(6) *Radar (RAD).* The radar mode provides vertical control of the aircraft to maintain a constant altitude above the ground level, as measured by a radar altimeter.

(7) *Approach (APP).* The approach mode provides vertical control of the air-

craft to automatically fly the glide slope path of the instrument landing approach system.

b. Operate the equipment for any particular type of operation by performing the following steps:

(1) Starting procedure (para 38).
(2) Pilot preflight operation procedure (para 39).
(3) Inflight operation procedure (para 40).
(4) Stopping procedure (para 41).

38. Starting Procedure (Fixed-Wing)

Caution: **Remove the aircraft control locking devices or place them in the unlocked position and check all controls for freedom and full travel. If an abnormal indication is obtained during the starting procedure, turn the AUTO PILOT engage switch off and refer to the trouble isolation chart checklist for suggested corrective measures.**

a. Preliminary Switch Settings.

Switch	Required position
Roll control (TURN knob) (fig. 24) ..	Center Detent
ROLL TRIM control (fig. 24)	Center mark aligned with index
AUTO PILOT engage switch (fig. 23)	Off
VERTICAL engage switch (fig. 23)	Off
LATERAL engage switch (fig. 23)	Off
VERTICAL select switch (fig. 23)	Any
LATERAL select switch (fig. 23)	Any

Note. Dc power must be supplied to the automatic flight control system before applying alternating-current (ac) power.

b. Preliminary Power Application. Dc electrical power must be available within the aircraft from any of the following sources: aircraft batteries, aircraft generators (when the aircraft engines are running), or from an external dc supply.

(1) Turn the aircraft 27-volt dc power supply on and check the dc voltmeter. It should read between 24 and 30 volts.
(2) Turn the ac power supply on and check the ac voltmeter. It should read between 110 and 120 volts.

c. Automatic Flight Control System Engagement.

(1) Operate the gyroscope, wait 2½ minutes for gyroscope erection. The automatic flight control system cannot be engaged until the gyroscope has had 2½ minutes in which to complete its fast erection cycle. This time-cycle is necessary to assure the proper erection of the gyroscope.
(2) Turn the AUTO PILOT engage switch to ON.

Caution: **If all three servoeffort indicators (fig. 24) are not centered, do not continue with starting procedure. Report malfunction to higher echelon Signal Corps maintenance personnel.**

d. Navigational Coupler Engagement.

(1) The auxiliary equipment used with each mode of operation must be powered electrically before the navigational coupler may be engaged.
(2) The recommended preflight procedures for each set of auxiliary equipment should be performed before the navigational coupler engagement is attempted.
(3) When the above steps have been completed and the AUTO PILOT engage switch (attitude) is engaged, the LATERAL select switch and/or the VERTICAL select switch may be set to the desired position and the lateral or vertical modes engaged.

39. Pilot Preflight Operation Procedure (Fixed-Wing)

This procedure is used by the pilot to give maximum assurance that the equipment is functioning correctly.

a. Turn on the main aircraft inverter and note that the AUTO PILOT engage switch (attitude) (fig. 23) will not engage (hold in) in the ON position before 2½ minutes have elapsed. After a 2½-minute delay, note that this switch will engage (hold in).

b. Operate the pilot release switch (fig. 25) and note that the AUTO PILOT engage switch (attitude) disengages (fig. 23).

c. Re-engage the AUTO PILOT engage switch (attitude) and rotate the roll control (TURN knob) to the right. Note that the control stick (wheel) moves to the right. Rotate the roll control (TURN knob) to the left. Note

that the control stick (wheel) moves to the left. Recenter the roll control (TURN knob).

d. Rotate the ROLL TRIM control to the right and left and note that the control stick (wheel) moves right and left in response. Recenter the ROLL TRIM control.

e. Push the pitch control (beep switch) forward (fig. 25) and note that the control stick (wheel) moves forward. Pull the pitch control (beep switch) aft and note that the control stick (wheel) moves aft. Retrim the control stick (wheel) to neutral, using the pitch control (beep switch).

f. Gently overpower the system by forcing the control stick (wheel) right and left, and note that the AIL (roll) servoeffort indicator moves counterclockwise and clockwise.

g. Gently overpower the system by forcing the control stick (wheel) fore and aft and note that the EL (pitch) servoeffort indicator moves up and down.

h. Force the control stick (wheel) aft and hold. Note that the aircraft stick (wheel) moves slowly to give nosedown trim and that the EL (pitch) servoeffort indicator deflects nosedown. Force the control stick (wheel) forward and hold. Note that the aircraft stick (wheel) moves slowly to give noseup trim and that the EL (pitch) servoeffort indicator deflects noseup.

i. Gently overpower the system by forcing the rudder pedals right and left. Note that the RUD (yaw) servoeffort indicator moves left and right.

40. Inflight Operation Procedure (Fixed-Wing)

Caution: **Do not engage the equipment unless all three servoeffort indicators (RUD, AIL, and EL) are centered (fig. 23).**

a. Engagement. Perform the starting procedure for engagement of the automatic flight control system as given in paragraph 38*a, b,* and *c.* If the AUTO PILOT engage switch (attitude) (fig. 23) is engaged during a climb or glide, the aircraft will continue to climb or glide at the prevailing pitch attitude. If the system is engaged while the aircraft is executing a banked maneuver, the aircraft will roll out level and maintain the aircraft established heading at the time of engagement. The automatic flight control system will align itself with the existing pitch attitude and heading attitude at the time of engagement, but will level the aircraft from a roll. The system may be engaged in any pitch attitude of the aircraft up to ±30° and roll attitudes of the aircraft up to ±60°.

b. Command Operation.

(1) *Pitch attitude.* The rate of aircraft climb and descent (pitch attitude) may be set by the use of the pitch control (beep switch) on the flight controller (fig. 24). Pushing the pitch control (beep switch) forward, will introduce a fixed nosedown pitch rate. Pulling the pitch control (beep switch) aft will produce a fixed noseup pitch rate. When the pitch control (beep switch) is released, the system will maintain the aircraft in the commanded attitude.

(2) *Turns.* To establish a coordinated turn, rotate the roll control (TURN knob) on the flight controller (fig. 24) out of detent to the right for a right turn or to the left for a left turn. Return to a level attitude by rotating the roll control (TURN knob) back into its detent position.

(3) *Roll trim.* To trim the aircraft roll attitude without a heading change, adjust the ROLL TRIM control (fig. 24) to the right or left proportional to the amount of roll trim needed.

c. Vertical Navigational Coupler Operation. To operate the vertical coupler functions, the AUTO PILOT engage switch (attitude) must be placed at ON (fig. 23). Also, the applicable navigational aid must be energized.

(1) *Barometric altitude control.*

(a) Set the VERTICAL select switch to BAR.

(b) Operate the VERTICAL engage switch (altitude) to ON. The aircraft will now be automatically stabilized to a constant barometric altitude.

(c) Changes in altitude are accomplished by disengaging the VERTICAL engage switch (altitude), commanding the change in altitude with the pitch control (beep switch)

(fig. 24), and reengaging the VERTICAL engage switch (altitude) (fig. 23).

(2) *Radar altitude control.*

(a) Set the VERTICAL select switch to RAD.

(b) Operate the VERTICAL engage switch (altitude) to ON. The aircraft will now be stabilized to a constant radar altitude.

(c) Changes in altitude are accomplished by disengaging the VERTICAL engage switch (altitude), commanding the change in altitude with the pitch control (beep switch) (fig. 24), and reengaging the VERTICAL engage switch (altitude) (fig. 23).

Caution: **Over a period of time, if the barometric altitude of the aircraft changes more than ±400 feet, disengage and reengage the VERTICAL engage switch (altitude). Loss of altitude stabilization will otherwise occur.**

(3) *Approach control.*

Note. The constant altitude portion of the approach may be made with the VERTICAL select switch in the barometric (BAR) or radar (RAD) mode.

(a) Rotate the VERTICAL select switch to APP.

(b) When the aircraft ILS glide path indicator shows zero glide path error, operate the VERTICAL engage switch (altitude) to ON.

(c) The aircraft will now automatically fly the glide path beam.

d. Lateral Navigational Coupler Operation. For the following discussion, it is assumed that the aircraft is under cruise conditions with the automatic flight control system engaged, AUTO PILOT engage switch (altitude) is ON, and that the conditions given in paragraph 38*d* have been met.

(1) *Heading select.*

(a) Rotate the LATERAL select switch to HDG.

(b) Set the heading select indicator to the desired heading.

(c) Operate the LATERAL engage switch (steering) to ON. The aircraft will now perform automatically coordinated turns to maintain the selected heading.

(d) Changes in aircraft heading may be made by rotating the heading select indicator.

(2) *VOR select.*

(a) Rotate the LATERAL select switch to VOR.

(b) Select the desired VOR frequency and aircraft heading.

(c) Operate the roll control (TURN knob) to manually bracket the VOR beam to less than 20° of the heading error and less than half-scale indication on the aircraft course indicator.

(3) *Localizer select.*

Caution: **Do not engage the lateral LOC mode on back course ILS.**

(a) Rotate the LATERAL select switch to LOC.

(b) Fly the aircraft to intercept the ILS localizer beam at a 45° angle. When the aircraft localizer indicator needle just begins to move away from the stops, operate the LATERAL engage switch (steering) to ON. The aircraft will now perform coordinated turns to automatically fly the localizer beam.

(c) At the point where the aircraft glide path indicator shows zero error, rotate the VERTICAL select switch to APP, whether or not the VERTICAL engage switch (altitude) is turned on or off. Operate the VERTICAL engage switch (altitude) to ON. The aircraft will fly on the glide path beam. See *c*(3) above for normal glide path approach operation.)

(4) *Navigation select.*

(a) Rotate the LATERAL select switch to NAV.

(b) Select the desired course on the panel equipment furnished with the Doppler navigation system.

(c) Fly the aircraft until the Doppler navigation system course indicator shows zero error. Operate the LATERAL engage switch to ON. The aircraft will now perform an auto-

matically coordinated turn to maintain the desired course.

41. Stopping Procedure (Fixed-Wing)

a. Monitor the aircraft controls. Prepare to take over manual operation.

b. The automatic flight control system may be turned off in two ways:

(1) Place the AUTO PILOT engage switch (attitude) in the off position.

(2) Press the pilot release switch on the control stick (fig. 25).

Note. The AUTO PILOT engage switch (attitude) (fig. 23) will automatically be turned off when either ac or dc power is lost. In all cases of AUTO PILOT disengagement, the standby light (a steady amber light) will show. If the disengagement is due to a power failure, operation of the power failure test switch located adjacent to the standby light will extinguish the light. If the light does not go out, the system is ready to be reengaged.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

42. Operation With Command Mode Malfunctioning

a. Overpowering System. The individual control channels of the automatic flight control system can be overpowered. If the controls have been overpowered because of a malfunction, the system should be disengaged by momentarily pressing the pilot release switch on the control stick (wheel) (fig. 25).

b. Command Mode Malfunction. If the action of the flight controller is lost, the system can still be used for stabilization.

(1) Center the roll control (TURN knob) into detent (fig. 24).
(2) Center the ROLL TRIM control.
(3) The pilot should manually establish the attitude of the pitch, roll, and yaw axes.
(4) Set the AUTO PILOT engage switch to ON (fig. 23).
(5) Changes in attitude are made by disengaging the AUTO PILOT engage switch.
(6) Manually position the aircraft to the new attitude.
(7) Set the AUTO PILOT engage switch (attitude) to ON to hold the new attitude.

43. Operation With Other Modes Malfunctioning

If one of the lateral modes or vertical modes malfunctions, select another mode if possible or disengage the LATERAL and VERTICAL engage switches (fig. 23) and continue the flight in the stabilization mode (AUTO PILOT engage switch (attitude) to ON). Changes in flight attitude are made by pilot imposed commands from the flight controller.

44. Operation Under Adverse Conditions

The automatic flight control system is designed to operate under various climatic conditions, including a temperature range of —67° to 131° F. The effects of temperature extremes and other climatic conditions such as dust and humidity are lessened by the protection which the aircraft gives to the components of the automatic flight control system. The following paragraphs provide procedures that should be taken to minimize the effects of unusual climatic conditions.

a. Arctic Climates. Be sure that the ambient temperature is −67° F or above before engaging the automatic flight control system.

b. Tropical Climates. Extremes of humidity and normal tropical heat will not affect the operation of the system.

c. Desert Climates. Keep the equipment as free from dust as possible. Be sure that the ambient temperature is 131° F or below before engaging the automatic flight control system.

CHAPTER 3

OPERATING INSTRUCTIONS, HELICOPTER

Section I. OPERATOR'S CONTROLS AND INDICATORS (HELICOPTER)

Note. This section describes, locates, and illustrates the various controls and indicators of the autopilot system used by the operator. The same controls and indicators are used by the maintenance personnel.

45. Helicopter Navigational Coupler

The navigational coupler used in helicopters is identical with that used in fixed-wing aircraft. Refer to paragraph 34 for the controls and their functions.

46. Helicopter Controls

The controls listed below are not supplied as part of the automatic flight control system but are supplied as part of the helicopter in which the automatic flight control system is installed.

Control or indicator	Function and location
Pilot release switch (fig. 25).	Flight control stick location. Provides quick disconnect of system by removing power from AUTO PILOT engage switch.
Beep switch (fig. 25).	Flight control stick location. Pilot fingertip command to change pitch and roll attitude of the aircraft.
Magnetic brake switch (fig. 25).	Flight control stick location. Allows pilot to release centering springs which position flight controls to establish new attitude of aircraft.
Rpm control stick (fig. 26).	Collective pitch (flight) control stick location. Engages rpm control interlock.
Elapsed time indicator (fig. 11).	Attitude reference control location Subminiature elapsed time indicator records total operating time of attitude reference control.
Standby light	Installation hardware (para 23*b*(1)). After autopilot system power is applied, the steady amber light will denote that the autopilot system is ready to be engaged. After the system has been initially engaged, the amber light denotes that the system has become disengaged either by pilot operation or by power failure.
YAW SAS light	Installation hardware (para 23*b*(2)). After initiation of a pilot-commanded turn, the green light denotes loss of the heading hold function.
Heading lock switch (fig. 26).	Collective pitch control stick location. Reengages heading hold function and extinguishes YAW SAS light after completion of a pilot-commanded turn.

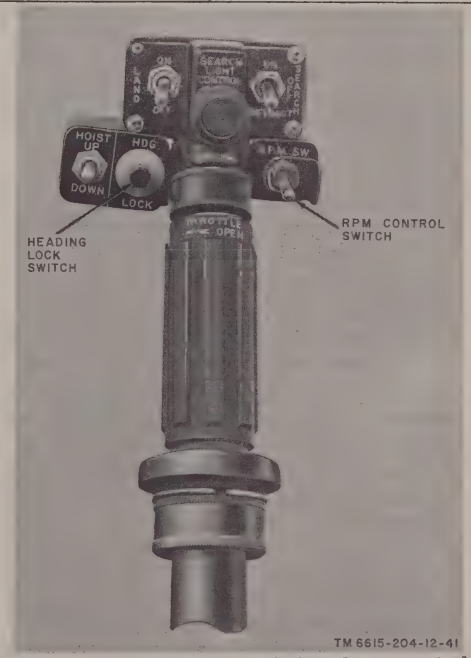

Figure 26. Heading lock switch and rpm control switch, typical location.

Section II. OPERATION UNDER USUAL CONDITIONS (HELICOPTER)

47. Types of Operation (Helicopter)

a. The various types of operation when using the automatic flight control system are listed in paragraph 37*a*.

b. To operate the equipment for any particular type of operation, perform the following procedures:

(1) Starting procedure (para 48).
(2) Preflight operation procedure (para 49).
(3) Inflight operation procedure (para 50).
(4) Stopping procedure (para 51).

48. Starting Procedure (Helicopter)

Note. Check all aircraft controls for freedom and full travel; place all controls in a centered position.

a. Preliminary Switch Settings (fig. 23). Check that the positions of the following switches are as indicated below:

Switches	Position
AUTO PILOT engage (attitude)	Off
VERTICAL engage (altitude)	Off
LATERAL engage (steering)	Off
VERTICAL select	Any
LATERAL select	Any

***Caution*: Dc power must be supplied to the automatic flight control system before turning on the aircraft ac power.**

b. Primary Power Application.

(1) Turn the aircraft 27-volt dc power supply on and check the dc voltmeter reading. It should read between 24 and 30 volts.
(2) Turn the aircraft ac power supply on and check the ac voltmeter reading. It should read between 110 and 120 volts.

c. Automatic Flight Control System Engagement. To engage the automatic flight control system, refer to paragraph 38*c*.

d. Navigation Coupler Engagement. To engage the navigational coupler, refer to paragraph 38*d*.

49. Pilot Preflight Operation Procedure (Helicopter)

This procedure is intended to be used by the pilot to give maximum assurance that the equipment is functioning correctly. The engine should be running and the rotor system engaged.

a. Turn main aircraft inverter on. Note that the AUTO PILOT engage switch (attitude) (fig. 23) will not hold in before 2½ minutes have elapsed.

b. After 2½ minutes, note that the AUTO PILOT engage switch (attitude) will hold in.

c. Operate the pilot release switch on the control stick and note that the AUTO PILOT engage switch (attitude) will disengage.

d. Reengage the AUTO PILOT engage switch (attitude) and push beep switch forward. Note that the rotor tip path plane tilts nosedown.

e. Push the beep switch (fig. 25) aft and note that the rotor tip path plane tilts noseup. Continue to hold the beep switch aft for 2 seconds after the tip path plane stops tilting.

f. Momentarily depress the magnetic brake switch (fig. 25) and note that the tip path plane tilts nosedown to approximately the neutral position.

g. Repeat *d*, *e*, and *f* above in roll while pushing the beep switch left and right. The left and right rotor tip path plane will tilt and return to the neutral position when the magnetic brake switch (fig. 25) is depressed.

h. Push lightly on a rudder pedal and note a resistance to motion. Increase the force and note that the rudder pedal will move to and remain in a selected position. Repeat for the opposite rudder pedal.

i. Pull the beep switch aft and note that the rotor tip path plane tilts noseup. Continue to hold the beep switch aft for 2 seconds after the tip path plane stops moving.

j. Operate the pilot release switch (fig. 25) and note that the rotor tip path plane tilts nosedown to approximately the neutral position. Reengage the AUTO PILOT engage switch (attitude).

k. Repeat *h* and *i* above in roll attitude, operating the beep switch to the right and note the right tilt of the rotor tip path plane.

l. Rotate the VERTICAL select switch to the BAR position. Set the rotor rpm to flying speed. Engage the VERTICAL engage switch (altitude) to the ON position.

m. Pull up lightly on the collective pitch

control stick (controls attitude) and note that there is a resistance to motion. An increase in the upward force will begin to move the collective pitch control stick up, and an increase in the downward force will move the stick down.

n. Reduce the engine rpm and note that the VERTICAL engage switch (altitude) disengages.

50. Inflight Operation Procedure (Helicopter)

a. Engagement. Perform the starting procedure for engagement of the automatic flight control system engagement as given in paragraph 48. This may be done before takeoff. The automatic flight control system will automatically maintain pitch attitude, roll attitude, and constant heading. The system may be engaged at any attitude.

b. Command Operation.

(1) *Pitch and roll attitude.* Three methods of changing pitch and roll attitude are available to the pilot.

(a) Temporary pitch and roll attitude changes may be made normally by using the flight control stick. When the flight control stick is released, the automatic flight control system will return the aircraft to its original attitude.

(b) Permanent attitude changes may be made through the use of the magnetic brake switch (fig. 25). The flight control stick may be moved to produce an attitude change as in (*a*) above. When the desired attitude is obtained, operate the magnetic brake switch. The helicopter will now be stabilized about the new attitude. The same effect may be obtained by reversing the sequence; that is, by first operating the magnetic brake switch and holding the switch, then maneuvering the aircraft to the desired attitude. When the magnetic brake switch is released, the new attitude will be automatically maintained.

(c) Small permanent trim changes in attitude may be made through the use of the beep switch (fig. 25). Operation of the beep switch forward produces a fixed rate of change in pitch attitude in a nose-down direction. When the switch is released, the new attitude will be maintained. Conversely, if the switch is operated in the aft direction, the pitch attitude will change at the same fixed rate in a noseup direction. When the switch is released, the new attitude will again be automatically maintained. Identical operation in roll is obtained by moving the beep switch right or left. A beep switch change of attitude may not be made simultaneously in the pitch and roll modes.

Caution: **If large beep switch changes result in the loss of stability, operate the magnetic brake switch.**

(2) *Heading.* Two methods are available to the pilot to change aircraft heading.

(a) Turns may be obtained under hover or cruise conditions by pilot-applied forces to the pedals. The aircraft will change heading in the direction of the pilot-applied force at a rate proportional to the magnitude of the force above a small preload level. The preload allows the pilot to rest his feet on the rudder pedals without commanding unintentional turns. After initiation of a turn, the YAW SAS (stability augmentation system) light (green, para 23*b* (2)), will come on, indicating loss of the heading hold function. After completion of the turn, operation of the heading lock switch (fig. 26) on the collective pitch control stick will extinguish the light, and the aircraft will again hold a constant heading.

(b) Automatically coordinated turns may be obtained within the cruising speed range of the aircraft by commanding a roll attitude change through the control stick. Refer to *b*(1) and *b*(1)(*b*) above. The roll attitude change must be initiated by moving the flight control stick to obtain the automatically coordinated turn. Operate the magnetic

brake switch when the desired roll attitude has been obtained. When the turn is completed and the aircraft is rolled out to a level attitude, a force exceeding the preload level must be applied to either the right or left pedal to again provide automatic constant heading stabilization.

c. Rpm Control. The rpm control may be engaged at any time after the initial 2½-minute system delay is over. *The engagement should be performed after takeoff for the best operation.*

Caution: **Engine rpm must be maintained at the desired value for a period of 5 seconds before engagement of the rpm control switch.**

(1) Set the throttle control to the desired engine speed.
(2) Turn on the rpm control switch. The rpm control switch will now maintain the engine speed.
(3) To change the engine speed, first turn off the rpm control switch.
(4) Set the engine to the new speed.
(5) Reengage the rpm control switch.

Note. The rpm control switch may be disengaged by overpowering the throttle. At a preset force level, the rpm control switch will automatically disengage.

d. Vertical Navigational Coupler Operation. In order to operate the vertical coupler functions, the AUTO PILOT engage switch (attitude) (fig. 23) and the rpm switch must be ON. Also, the applicable navigational aid must be energized.

(1) *Barometric altitude control.*
(a) Set the VERTICAL select switch to the BAR position.
(b) Place the VERTICAL engage switch (altitude) to the ON position and reduce the collective pitch control stick friction to a minimum value. The aircraft will now be automatically stabilized to a constant barometric altitude.
(c) Changes in altitude are accomplished by disengaging the VERTICAL engage switch (altitude), commanding the change altitude manually, and reengaging the VERTICAL engage switch (altitude).

(2) *Radar altitude control.*
(a) Set the VERTICAL select switch to the RAD position.
(b) Operate the VERTICAL engage switch (altitude) to the ON position and reduce the collective pitch control stick friction to a minimum. The aircraft will now be stabilized to a constant radar altitude.
(c) Changes in altitude are accomplished by disengaging the VERTICAL engage switch (altitude), commanding the change in altitude manually, and reengaging the VERTICAL engage switch (altitude).

Caution: **Over a period of time if the barometric altitude changes more than ±400 feet, it is necessary to disengage and reengage the vertical control channel. Loss of altitude stabilization will otherwise occur.**

(3) *Approach.*

Note. The constant altitude portion of the approach must be made with the VERTICAL select switch in the barometric (BAR) or radar (RAD) mode.

(a) Rotate the VERTICAL select switch to the APP position.
(b) When the aircraft ILS glide path indicator shows zero glide path error, operate the VERTICAL engage switch (altitude) to the ON position.
(c) The aircraft will now automatically fly the glide path beam.

e. Lateral Navigational Coupler Operation. For the following discussion it is assumed that the aircraft is under cruise conditions with the automatic flight control system engaged (AUTO PILOT engage switch (attitude) is in the ON position) and that the conditions of paragraph 48*d*, navigational coupler engagement, have been met.

Caution: **After disengaging the lateral coupler, a force exceeding the rudder preload force must be applied to either the right or left pedal to allow the automatic flight control system to maintain constant heading.**

(1) *HDG select* (fig. 23).
(a) Rotate the LATERAL select switch to HDG.

(b) Set the heading select indicator to the desired heading.

(c) Operate the LATERAL engage switch (steering) to the ON position. The aircraft will now perform automatically coordinated turns to maintain the selected heading.

(d) Changes in aircraft heading may be made by rotating the heading select indicator.

(2) *VOR select* (fig. 23).

(a) Rotate the LATERAL select switch to the VOR position.

(b) Select the desired VOR frequency and heading.

(c) Introduce commands into the automatic flight control system through the manual controls to bracket the VOR beam to less than 20° of the heading error and less than half-scale indication on the aircraft course indicator.

(d) The aircraft will now perform automatically coordinated turns to fly the selected VOR radial.

(3) *Localizer select.*

Caution: **Do not engage the LATERAL LOC mode on back course ILS.**

(a) Rotate the LATERAL select switch to the LOC position.

(b) Fly the aircraft to intercept the ILS localizer beam at a 45° angle. When the aircraft localizer indicator needle just begins to move away from the stops, operate the LATERAL engage switch (steering) to the ON position. The aircraft will now perform coordinated turns to automatically fly the localizer beam.

(c) At the point where the aircraft glide path indicator shows zero error, rotate the VERTICAL select switch to the APP position and continue as in *d*(3) above for normal glide path approach operation.

(4) *Navigation select.*

(a) Rotate the LATERAL select switch to the NAV position.

(b) Select the desired course on the panel equipment furnished with the Doppler navigation system.

(c) Fly the aircraft until the Doppler navigation system course indicator shows zero error. Operate the LATERAL engage switch (steering) to the ON position. The aircraft will now perform automatically coordinated turns to maintain the desired course.

51. Stopping Procedure (Helicopter)

a. Monitor the aircraft controls. Prepare to take over manual operation.

b. The automatic flight control system may be turned off by placing the AUTO PILOT engage switch (attitude) to the OFF position or by pressing the pilot release switch on the control stick.

Note. The AUTO PILOT engage switch (attitude) (fig. 23) will automatically be turned off when either ac or dc power is lost. In all cases of AUTO PILOT disengagement, the standby light (a steady amber light) will glow. If the disengagement is caused by power failure, operation of the power failure test switch, adjacent to the standby light, will extinguish the light. If the light does not go out, the system is ready to be reengaged.

Section III. OPERATION UNDER UNUSUAL CONDITIONS (HELICOPTER)

52. Operation With Command Mode Malfunctioning (Helicopter)

a. Overpowering System. The individual control channels of the automatic flight control system can be overpowered. If the controls have been overpowered because of a malfunction, disengage the system by momentarily pressing the pilot release switch on the control stick.

b. Command Mode Malfunction.

(1) When the beep switch signal is not effective, it will be necessary to establish the flight attitude of the aircraft by overpowering the system; then, by operating the magnetic brake switch (fig. 25), the new attitude will be maintained.

(2) When the automatic flight control sys-

tem does not stabilize the aircraft attitude after operating the magnetic brake switch to adjust the flight control stick centering device, disengage the autopilot system. Maneuver manually to the desired aircraft attitude and reengage the automatic flight control system.

(3) When pilot-applied forces to the rudder pedals do not produce permanent changes in heading, three alternatives are available:

(a) Make automatically coordinated lateral turns by commanding a bank angle through the flight control stick.

(b) Set the LATERAL select switch to the HDG position (fig. 23) and engage the LATERAL engage switch (steering). Change the aircraft heading select indicator to command heading changes.

(c) Disengage the AUTO PILOT engage switch (attitude), turn to the new heading manually, and reengage the AUTO PILOT engage switch (attitude).

(d) If the procedures in *(a)*, *(b)*, and *(c)* above do not produce correct results, permanently disengage the autopilot system.

53. Operation With Other Modes Malfunctioning (Helicopter)

If one of the lateral modes, or vertical modes malfunctions, select another mode if possible or disengage the LATERAL and VERTICAL engage switches and continue the flight in stabilization mode (AUTO PILOT engage switch (attitude) to the ON position), utilizing the available command modes.

54. Operation Under Adverse Conditions

Refer to paragraph 44 for operation under adverse conditions.

CHAPTER 4

OPERATOR'S MAINTENANCE INSTRUCTIONS

55. Scope of Operator's Maintenance

a. Operator's maintenance for the automatic flight control system as installed by either fixed-wing aircraft or helicopters is limited to an accurate reporting of system malfunctions experienced during preflight operation (para 39 and 49) or inflight operation (para 40 and 50).

b. There are no special tools, materials, or test equipment required for operator's maintenance.

56. Reporting Malfunctions

Be as specific as possible when describing malfunctions. Accurate reporting of all details of system malfunctions will permit maintenance personnel to localize the trouble to specific system components.

CHAPTER 5
ORGANIZATIONAL MAINTENANCE FOR FIXED-WING AIRCRAFT

Section I. PREVENTIVE MAINTENANCE (FIXED-WING)

57. Scope

a. This chapter covers organizational maintenance of the automatic flight control system as installed in fixed-wing aircraft.

b. Organizational maintenance of the automatic flight control system consists of the following:

(1) Preventive maintenance (para 58).
(2) Preflight inspection (para 59*a*).
(3) Postflight checks (para 59*b*).
(4) Visual inspection (para 60).
(5) Troubleshooting procedure (para 61).
(6) Component removal and replacement (para 62 through 75).

58. Preventive Maintenance (Fixed-Wing)

The following steps should be performed periodically:

a. Check completeness and general condition of the equipment.

b. Remove dirt and moisture from jacks, plugs, and component panels.

c. Inspect controls for binding, scraping, excessive looseness, misalignment, and positive action.

d. Check for normal operation (para 59).

e. Clean and tighten exterior of components and cases, rack mounts, shock mounts, and cable connections.

f. Inspect cases, mountings, and exposed metal surfaces for rust, corrosion, and moisture.

g. Inspect cord, cable, wire, and shock mounts for cuts, breaks, fraying, deterioration, kinks, and strain.

h. Inspect for looseness of accessible items such as switches, knobs, connectors, and panel lights.

i. Clean nameplates, dial, and meter windows.

j. Inspect meters for damaged glass and cases.

59. Operational Check (Fixed-Wing)

a. Preflight Checks.

(1) Turn on the main aircraft inverter and note that the AUTO PILOT engage switch (attitude) (fig. 23) will not hold in the ON position before 2½ minutes have elapsed. After a 2½-minute delay, the amber standby light comes on, and the AUTO PILOT engage switch (attitude) will hold in.

(2) Operate the pilot release switch (fig. 25); the AUTO PILOT engage switch (attitude) (fig. 23) disengages.

(3) Reengage the AUTO PILOT engage switch (attitude) and rotate the roll control (TURN knob) (fig. 24) to the right; the control wheel moves to the right. Rotate the roll control (TURN knob) to the left; the control wheel moves to the left. Recenter the roll control (TURN knob).

(4) Rotate the ROLL TRIM control to the right and left and note that the control wheel moves right and left in response. Recenter the ROLL TRIM control.

(5) Push the pitch control (beep switch) forward; the control stick moves forward. Pull the pitch control (beep switch) aft; the stick moves aft. Retrim the stick to neutral by using the pitch control (beep switch).

(6) Overpower the autopilot system by forcing the control wheel left and right and note that the AIL (roll) servoeffort indicator moves counterclockwise and clockwise.

(7) Overpower the autopilot system by forcing the control stick fore and aft and note that the EL (pitch) servoeffort indicator moves up and down.

(8) Force the stick aft and hold. The trim wheel moves slowly to give nosedown trim and the EL (pitch) servoeffort indicator deflects nosedown. Force the stick forward and hold; the trim wheel moves slowly to give noseup trim and that the EL (pitch) servoeffort indicator deflects noseup.

(9) Overpower the autopilot system by forcing the rudder pedals right and left. The RUD (yaw) servoeffort indicator moves left and right.

(10) Rotate the VERTICAL select switch (fig. 23) to the BAR position. Engage the VERTICAL engage switch (altitude). The altitude control will now be connected to the pitch axis control channel.

(11) Rotate the VERTICAL select switch to the RAD position. The VERTICAL engage switch (altitude) disengages. Attempt to engage the VERTICAL engage switch (altitude) and note that it will not engage unless power is applied to the radar altimeter.

Note. The procedure in (12), (14), (15), and (16) below may be completed only if a navigational signal is available.

(12) Rotate the VERTICAL select switch to the APP position. The VERTICAL engage switch (altitude) disengages. Attempt to reengage the VERTICAL engage switch and note that it will not engage unless power is applied to the glide path system. With power applied to the glide path system, the VERTICAL engage switch (altitude) will engage and the control stick will move to reduce any indicated glide path error.

(13) Rotate the LATERAL select switch to the HDG position. Set the heading select indicator to agree with the aircraft heading and engage the LATERAL engage switch. Rotate the heading select indicator to command a left and right turn and note that the control wheel moves to the left and right.

(14) Rotate the LATERAL select switch to the VOR position; the LATERAL engage switch (steering) disengages. Engage the LATERAL engage switch (steering); the control wheel will move to reduce any indicated path error to zero.

(15) Rotate the LATERAL select switch to the LOC position; the LATERAL engage switch (steering) disengages. Attempt to reengage LATERAL engage switch (steering) and note that it will not reengage if power is not applied to the localizer system (ILS). The LATERAL engage switch (steering) will engage if power is applied to the localizer receiver and the control wheel will move laterally to reduce any indicated localizer error to zero.

(16) Rotate the LATERAL select switch to the NAV position; the LATERAL engage switch (steering) disengages. Attempt to reengage LATERAL engage switch (steering) and note that it will not reengage if power is not applied to the navigation system. When power is applied to the navigation system, the LATERAL engage switch (steering) will engage and the lateral control wheel will move laterally to reduce any indicated path error to zero.

b. Postflight Checks. There are no postflight checks.

Section II. TROUBLESHOOTING (FIXED-WING)

60. Visual Inspection

Check to see that:

a. All electrical connectors are firmly fastened.

b. All components are properly mounted and show no signs of damage.

c. All system controls are set in the proper position (para 38*a*).

d. All circuit breakers are engaged. Note any disengaged circuit breakers and determine the cause before continuing.

61. Troubleshooting Procedures

a. General. If the visual inspection in paragraph 60 is satisfactory, place the system in operation by applying ac and dc power; then proceed to the trouble isolation checklists (*d* below). If a malfunctioning component is not located by using the procedures in these check-

lists, report all symptoms observed and action taken to field maintenance personnel.

b. Test Plugs. The test plugs are included in the aircraft wiring. Refer to the wiring diagram for the specific aircraft to locate these test plugs for use in the trouble isolation checklists. These test plugs are designated W1P14 and W1P15 on the aircraft wiring diagram.

c. Replacement of Components. Refer to paragraphs 62 through 75 for details of component replacement.

d. Test Equipment and Tools Required. Multimeter TS–297/U is required for test voltage measurements from the test plugs included in the aircraft wiring. Multimeter TS–297/U is also required for voltage measurements essential for the replacement of the command pickoff (para 91*d*). Tool Equipment TE–41 includes the tools necessary for the disassembly, assembly, and organizational maintenance.

e. Fixed-Wing Trouble Isolation Checklist.

Item No.	Symptom	Functional tests	Corrective measures
1	AUTO PILOT engage switch (attitude, fig. 23) will not engage.	Check to see that ac and dc circuit breakers are in the ON position and that the roll control (TURN knob) is in the detent position (fig. 24).	Check for 27 vdc at test plug W1P15–C after 2½ minutes of power on. If no voltage appears, replace vertical gyro. Check for 27 vdc between W1P15–B and W1P15–M. If a voltage exists, replace pilot release switch. If no voltage is present, check W1P15–E and W1P15–F for 27 vdc with AUTO PILOT engage (attitude, fig. 23) switch manually held in the ON position. If 27 vdc appears at W1P15–E and not at W1P15–F, replace altitude reference control. If 27 vdc appears at both test points, replace navigational coupler.
2	LATERAL engage switch (steering) will not engage with AUTO PILOT switch (attitude) engaged.	Turn on the selected navigational aid.	Replace the navigational coupler.
3	VERTICAL engage switch (altitude) will not engage with AUTO PILOT switch (altitude) engaged.	With the VERTICAL select switch set at APP or RAD, check that appropriate receiver is turned on.	Replace the navigational coupler.
4	Pilot release switch (fig. 25) will not disengage the autopilot system.	Depress the pilot release switch, and check for 27 vdc from W1P15–B to W1P15–M.	If 27 vdc does not appear, replace pilot release switch. If 27 vdc does appear, replace navigational coupler.
5	Changing position of the LATERAL select switch (fig. 23) does not cause LATERAL engage switch (steering) to disengage.		Replace the navigational coupler.

Item No.	Symptom	Functional tests	Corrective measures
6	Changing position of the VERTICAL select switch does not cause VERTICAL engage switch (altitude) to disengage.		Replace the navigational coupler.
7	Improper pitch stabilization.	Check operation pitch control (beep switch).	If control surfaces move, replace vertical gyro. If surfaces do not move, check for a changing voltage (0 to 10 vdc) at W1P15–Y with pitch control (beep switch) operating. If changing voltage appears, replace pitch power unit. If no voltage change appears, replace attitude reference control and/or flight controller.
8	Barometric altitude hold inoperative.	Check pitch control (beep switch) operation, with VERTICAL engage switch (altitude) (fig. 23) engaged. Check pitch control (beep switch) (fig. 24) operation with VERTICAL engage switch (altitude) (fig. 24) disengaged.	If control surfaces move, replace attitude reference control. If control surfaces do not function, disengage switch. If no operation occurs, replace attitude reference control. If proper operation occurs, replace navigational coupler and altitude control.
9	RADAR altimeter altitude hold inoperative or glide path inoperative.	With VERTICAL select switch (fig. 23) in APP or RAD position, check to see that appropriate receiver is on.	Check pitch control (beep switch) (fig. 24) operation with VERTICAL engage switch (altitude) disengaged (fig. 23) then with the switch (altitude) engaged (fig. 23). If the surfaces operate with the switch disengaged and does not when engaged, replace the navigational coupler. If both positions operate the surfaces, replace the attitude reference control. If neither position operates the surfaces, check change in voltage (0-10 vdc) at W1P15–Y with pitch control (beep switch) operation (fig. 24). If a voltage change is observed, replace pitch power unit. If no voltage change is observed, replace attitude reference control. If all checks are satisfactory, replace the radar altimeter or glide path receiver.

Item No.	Symptom	Functional tests	Corrective measures
10	Pitch trim inoperative		Replace trim power unit.
11	Pitch transient	Observe EL (pitch) servo effort indicator on flight controller.	If indicator shows large deflection, replace pitch power unit. If no deflection is shown by indicator, replace attitude reference control and then navigational coupler.
12	Improper roll stabilization	Check operation of roll control (TURN knob). If control surfaces do not move, check change in voltage (0 to 10 vdc) at W1P15–X with rotation of roll control (TURN knob).	If control surface moves, replace the vertical gyro. If voltage appears, replace roll power unit. If no voltage appears, replace attitude reference control.
13	Roll control (TURN knob) does not operate properly.	Rotate ROLL TRIM control.	If control surface does not move, replace roll power unit. If control surface moves, replace attitude reference control or flight controller.
14	ROLL TRIM control does not operate properly.	Rotate roll control (TURN knob).	If control surfaces does not move, replace roll power unit. If control surface moves, replace attitude reference control or flight controller.
15	Roll transient	Observe AIL (roll) servo effort indicator on flight controller.	If indicator shows large deflection replace roll power unit. If no deflection is shown by indicator, replace attitude reference control and then navigational coupler.
16	No coordination in turns	See step 21.	
17	LOC, VOR, or NAV position of LATERAL engage switch inoperative.	Check to see that the appropriate receiver is in the ON position.	If roll control (TURN) knob operates control surface with LATERAL engage switch (steering) disengaged (fig. 23), replace navigational coupler. If roll control (TURN knob) does not operate control surface, check change in voltage (0 to 10 vdc) at W1P15–X with rotation of roll control (TURN knob) (fig. 24). If a voltage change is observed, replace attitude reference control. If trouble is not corrected, check LOC, VOR, NAV receiver.
18	HDG position of LATERAL engage switch inoperative.	Follow steps in paragraph 17.	Check the compass system.

Item No.	Symptom	Functional tests	Corrective measures
19	Improper heading stabilization.	Verify that the compass system signal is reliable. With equipment disengaged, manually displace the rudder pedals. Engage the system and manually recenter the rudder pedals. Remove force from the pedal.	If the rudder returns to its displaced position, replace altitude reference control. If rudder does not return to its displaced position, replace yaw power unit.
20	No turn coordination	With the AUTO PILOT engage switch (attitude) off, manually displace the rudder pedal. Engage the equipment and manually recenter the rudder. Remove force from the pedal.	If the rudder remains in the center position, replace yaw power unit. If the rudder returns to its displaced position, replace accelerometer.

Section III. COMPONENT REMOVAL AND REPLACEMENT (FIXED-WING)

62. Removal of Actuators, Electro-Mechanical, Rotary TG–78/ASW–12(V), TG–79/ASW–12(V), TG–80/ASW–12(V), and TG–81/ASW–12(V)

Remove the pitch, roll, yaw, and trim power units as follows:

a. Disconnect the electrical connector (fig. 6 and 7).

b. Loosen the four captive screws at the slanting break in the case which hold the servo drive assembly to the output drum and bracket assembly. (These screws are seen easily when the power unit is viewed from above.)

c. Lift up on the servo drive assembly to remove it from the output drum and bracket assembly.

d. Loosen the four screws (fig. 27) and remove the four washers; remove the calibration card from the power unit.

Note. Do not remove the output drum and bracket assembly.

63. Replacement of Actuators, Electro-Mechanical, Rotary TG–78/ASW–12(V), TG–79/ASW–12(V), TG–80/ASW–12(V), and TG–81/ASW–12(V)

Replace the pitch, roll, yaw, and trim power units as follows:

a. Replace the servo drive assembly on the output drum and bracket assembly (fig. 6 and 7).

b. Tighten the four captive screws at the slanting break in the case.

c. Connect the electrical connector.

d. Replace the calibration card on the power unit (fig. 27).

e. Replace the four washers and tighten the four screws.

Note. When replacing a power unit, be sure to remove the calibration card and reinstall it in the replacement power unit as shown in figure 27. When a replacement calibration card is supplied, compare the part numbers on each calibration card to be sure the parts are the same.

f. Record the hours of operation.

64. Removal of Accelerometer, Aircraft MX–2916/ASW–12(V)

(fig. 16)

a. Disconnect the electrical connector.

b. Disconnect the ground wire at the airframe.

c. Note the position of the arrow on the case.

d. Remove the four mounting screws, note the mounting position, and remove the accelerometer.

65. Replacement of Accelerometer, Aircraft MX–2916/ASW–12(V)

(fig. 16)

a. Place the new accelerometer in the same position from which the old accelerometer was

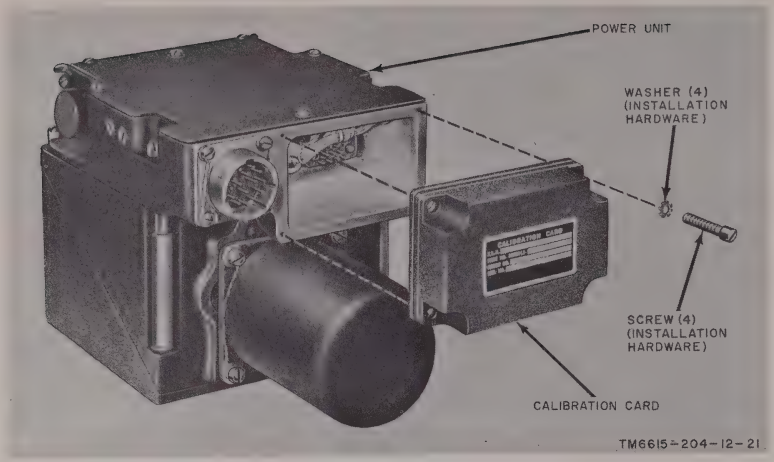

Figure 27. Calibration card installation.

removed; secure it with the four mounting screws.

b. Connect the ground wire to the airframe.

c. Connect the electrical connector.

d. Record the hours of operation.

66. Removal of Control, Altitude, Automatic Pilot C–3106/ASW–12(V)

(fig. 15)

a. Disconnect electrical connector J1.

b. Disconnect the static pressure input.

c. Remove the three mounting screws, and remove the altitude reference control.

67. Replacement of Control, Altitude, Automatic Pilot C–3106/ASW–12(V)

(fig. 15)

a. Place the new altitude reference control in position and secure it with the three mounting screws.

b. Connect the static pressure input.

c. Connect electrical connector J1.

d. Record the hours of operation.

68. Removal of Control, Attitude, Reference C–3108/ASW–12(V)

(fig. 11)

a. Remove electrical connectors J1, J2, and J3.

b. Remove the four mounting screws and remove the attitude reference control.

69. Replacement of Control, Attitude, Reference C–3108/ASW–12(V)

(fig. 11)

a. Place the new attitude reference control in position and secure it with the four mounting screws.

b. Connect electrical connectors J1, J2, and J3.

c. Record the hours of operation.

70. Removal of Controller, Flight, Automatic Pilot C–3107/ASW–12(V)

(fig. 28)

a. Disconnect the electrical connector.

b. Remove the three mounting screws from the underside of the flight controller.

c. Remove the flight controller.

71. Replacement of Controller, Flight, Automatic Pilot C–3107/ASW–12(V)

(fig. 28)

a. Place the new flight controller in position and secure it with the three mounting screws.

b. Connect the electrical connector.

c. Record the hours of operation.

72. Removal of Gyroscope, Displacement CN–601/ASW–12(V)

(fig. 17)

a. Disconnect electrical connector J3.

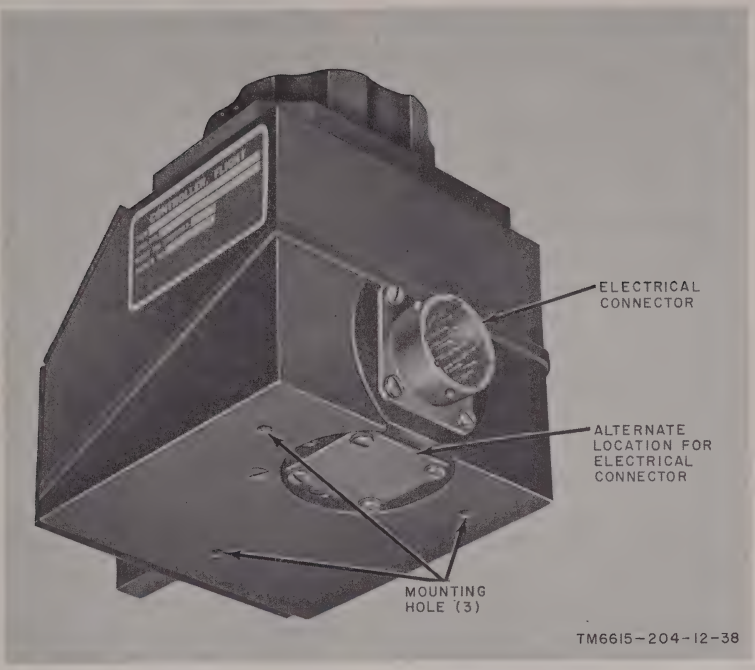

Figure 28. Flight controller installation details.

b. Remove the three mounting screws.

c. Remove the vertical gyro.

73. Replacement of Gyroscope, Displacement CN–601/ASW–12(V)

(fig. 17)

a. Place the new vertical gyro in position and secure it with the three mounting screws.

b. Connect electrical connector J3.

c. Record the hours of operation.

74. Removal of Coupler, Navigational CU–792/ASW–12(V)

(fig. 10)

a. Unfasten the four quick disconnect fasteners, releasing the navigational coupler from the instrument panel.

b. Disconnect electrical connectors J1 and J2.

c. Remove the navigational coupler.

75. Replacement of Coupler, Navigational CU–792/ASW–12(V)

(fig. 10)

a. Connect electrical connectors J1 and J2 to the navigational coupler.

b. Place the new navigational coupler in the instrument panel.

c. Secure the navigational coupler with the four quick disconnect fasteners.

d. Record the hours of operation.

CHAPTER 6

ORGANIZATIONAL MAINTENANCE FOR HELICOPTERS

Section I. PREVENTIVE MAINTENANCE (HELICOPTER)

76. Scope

a. This chapter covers organizational maintenance of the automatic flight control system as installed in helicopters.

b. Organizational maintenance of the automatic flight control system consists of the following:

(1) Preventive maintenance (para 77).
(2) Preflight checks (para 78*a*).
(3) Postflight checks (para 78*b*).
(4) Visual inspection (para 79).
(5) Troubleshooting procedures (para 80).
(6) Removal and replacement of components (para 81 through 91).

77. Preventive Maintenance (Helicopter)

The following steps should be performed periodically:

a. Check completeness and general condition of the equipment.

b. Remove dirt and moisture from jacks, plugs, and component panels.

c. Inspect controls for binding, scraping, excessive looseness, misalignment, and positive action.

d. Check for normal operation (para 78).

e. Clean and tighten exterior of components and cases, rack mounts, shock mounts, and cable connections.

f. Inspect cases, mountings, and exposed metal surfaces for rust, corrosion, and moisture.

g. Inspect cord, cable, wire, and shock mounts for cuts, breaks, fraying, deterioration, kinks, and strain.

h. Inspect for looseness of accessible items, such as switches, knobs, connectors, and panel lights.

i. Clean nameplates, dial, and meter windows.

j. Inspect meters for damaged glass and cases.

78. Operational Inspection (Helicopter)

a. Preflight Checks. This procedure gives maximum assurance that the automatic flight control system is functioning correctly. The engine should be running and the rotor system engaged.

(1) Turn the main aircraft inverter on. The AUTO PILOT engage switch (attitude) (fig. 23) will hold in the ON position after 2½ minutes have elapsed.
(2) After 2½ minutes, the amber standby light will come on and the AUTO PILOT engage switch (attitude) will hold in.
(3) Operate the pilot release switch on the flight control stick (wheel); the AUTO PILOT engage switch (attitude) will disengage.
(4) Reengage the AUTO PILOT engage switch (attitude) and push the pitch control (beep switch) forward. The rotor tip path tilts nosedown.
(5) Push pitch control (beep switch) aft; the rotor tip path plane tilts noseup. Continue to hold the pitch control (beep switch) aft for 2 seconds after the tip path plane stops tilting.
(6) Momentarily depress the magnetic brake switch; the tip path plane tilts nosedown to approximately the neutral position.
(7) Repeat (4), (5), and (6) above in roll, pushing the pitch control (beep switch) left and right; the left and right rotor tip path planes tilt, and return to neutral when the magnetic brake switch is depressed.
(8) Push lightly on a rudder pedal and note a resistance to motion. Increase the force; the rudder pedal will move to and remain in a selected position. Repeat for the opposite rudder pedal.
(9) Push pitch control (beep switch) aft;

the rotor tip path plane tilts noseup. Continue to hold the pitch control (beep switch) aft for 2 seconds after the tip path plane stops moving.

(10) Operate the pilot release switch; the rotor tip path plane tilts nosedown to approximately neutral position. Reengage the AUTO PILOT engage switch (attitude).

(11) Repeat (8) and (9) above in roll attitude, operating the pitch control (beep switch) to the right. The right tilt of the rotor tip path plane.

(12) Rotate the VERTICAL select switch to (fig. 23) the BAR position. Turn on the rpm switch. Turn the VERTICAL engage switch (altitude) to the ON position. The altitude control will now be connected to the pitch axis control channel.

(13) Pull up lightly on collective pitch control stick and note that there is a resistance to motion. An increase in force will automatically disengage the VERTICAL engage switch (altitude). A downward force will disengage the VERTICAL engage switch (altitude).

(14) Reengage the VERTICAL engage switch (altitude). Disengage the rpm control switch. The VERTICAL engage switch (altitude) will disengage.

(15) Reengage the rpm control switch and VERTICAL engage switch (altitude). Rotate the VERTICAL select switch to the RAD position. The VERTICAL engage switch (altitude) will disengage.

(16) Attempt to reengage the VERTICAL engage switch (altitude) in the RAD position; it will not engage unless power is applied to the radar altimeter.

(17) Rotate the VERTICAL select switch to the APP position and attempt to engage the VERTICAL engage switch (altitude). It will not engage unless power is applied to the glide path receiver.

(18) With engine rpm set to flying speed, turn the rpm control switch to ON. Reduce the rpm by the use of the throttle. Release the throttle and note that the rpm returns to engaged value. Disengage the rpm control switch and reduce the engine rpm.

(19) Rotate the LATERAL select switch to the HDG position. Set the heading indicator to agree with aircraft heading. Engage the LATERAL engage switch (steering). Rotate the heading indicator left and right and note that the rotor tip path plane tilts left and right in response.

Note. The steps in (20), (21), and (22) below are optional. They cannot be performed unless suitable navigational signals are available.

(20) Rotate the LATERAL select switch to the VOR position; the LATERAL engage switch (steering) disengages. Attempt to reengage. The LATERAL engage switch (steering) will not engage if power is not applied to the VOR equipment. With power applied to the VOR system and the autopilot system indicating an error, the lateral system will engage and the rotor tip path plane will tilt in a direction to reduce the path error to zero.

(21) Rotate the LATERAL select switch to the LOC position. The LATERAL engage switch (steering) disengages. Attempt to reengage the LATERAL engage switch (steering). It will not engage unless power is applied to the ILS localizer system. With power on the ILS localizer system, the LATERAL engage switch (steering) can be engaged. The rotor tip path plane will tilt in response to an indicated path error in a direction to reduce the error to zero.

(22) Rotate the LATERAL select switch to the NAV position. The LATERAL engage switch disengages. Attempt to reengage the LATERAL engage navigation system. With power applied to the navigation system, the LATERAL engage switch (steering) can be engaged and the lateral tip path plane will tilt in a direction to reduce an indicated path error to zero.

b. Postflight Checks. There are no postflight checks.

Section II. TROUBLESHOOTING (HELICOPTER)

79. Visual Inspection (Helicopter)

Check to see that:

a. All electrical connectors are firmly fastened.

b. All components are properly mounted and show no signs of damage.

c. All system controls are set in the proper position (para 48*a*).

d. All circuit breakers are engaged. Note any circuit breakers which are disengaged, and determine the cause before continuing.

80. Troubleshooting Procedures (Helicopter)

a. General. If the visual inspection (para 79) is satisfactory, place the system in operation by applying ac and dc power, then proceed to the trouble isolation checklist, *e* below. If a malfunctioning component is not located by using the procedures in this checklist, report all symptoms observed and action taken to field maintenance personnel.

b. Test Plugs. The test plugs are included in the aircraft wiring. Refer to the wiring diagram for the specific aircraft to locate these test plugs for use in the trouble isolation checklists. These test plugs are designated W1P22 and W1P23 on the aircraft wiring diagram.

c. Removal and Replacement of Components. Refer to paragraphs 80 through 91 for details of component removal and replacement.

d. Test Equipment and Tools Required. Refer to paragraph 61*d*.

e. Helicopter Trouble Isolation Checklist.

Item No.	Symptom	Functional tests	Corrective measures
1	AUTO PILOT engage switch (attitude) (fig. 23) will not engage.	Check that ac and dc circuit breakers are in the on position.	Check for 27 vdc at test plug W1P22–D after 2½ minutes of power ON. If no voltage appears, replace vertical gyro. Check for 0 volt at W1P22–A to ground. If voltage appears, replace pilot release switch. Check W1P22–F and W1P22–E for 27 vdc with AUTO PILOT engage switch (attitude) manually on the ON position; use W1P22–M for ground. If a voltage appears at W1P22–E and none at W1P22–F, replace attitude reference control. If a voltage appears at both points, replace navigational coupler.
2	LATERAL engage switch (steering) will not engage with AUTO PILOT switch (attitude) engaged.	Check that selected navigational aid is turned to ON.	If LATERAL engage switch (steering) will still not engage, replace the navigational coupler.
3	VERTICAL engage switch (altitude) will not engage with AUTO PILOT switch (attitude) engaged.	With select switch in APP or RAD position, check to see that the appropriate receiver is ON.	If VERTICAL engage switch (altitude) does not engage, replace the navigational coupler.
4	Pilot release switch will not disengage the autopilot.	With pilot release switch depressed, check for 27 vdc from W1P22–A to W1P22–M.	If voltage does not appear, replace pilot release switch (fig. 25). If voltage appears, replace navigational coupler.

Item No.	Symptom	Functional tests	Corrective measures
5	Improper pitch stabilization.	Check operation of beep switch with flexible shaft disconnected for viewing.	If shaft moves by beeping, replace vertical gyro.
			If flexible shaft does not move, check for a changing voltage (0 to 10 vdc) at W1P22–Y test plug with beep switch operating.
			If changing voltage appears, replace pitch power unit (H).
			If no voltage appears, replace attitude reference control.
		Check operation of beep switch in roll axis to verify that roll power unit will move.	If roll flexible shaft does not move, replace attitude reference control.
		Check operation of beep switch in pitch, forward, and aft movement.	If pitch power unit (H) will not move in either direction, replace attitude reference control.
			If pitch power unit (H) will move in one direction only, replace pitch control (beep switch).
6	Large pitch transients	Check for varying voltage (0 to 10 vdc) at W1P22–Y with beep switch operating.	For no voltage, replace attitude reference control.
			With voltage present, replace pitch power unit (H) or attitude reference control.
7	Improper stabilization in roll.	Check operation of beep switch by disconnecting flexible shaft and observing shaft while beep switch is operated.	If the shaft moves, replace the vertical gyro.
		Check for a changing voltage (0 to 10 vdc) at W1P22–X with the beep switch operating.	If no voltage appears, replace the attitude reference control.
			If voltage appears, replace the roll power unit.
		Check operation of beep switch in pitch axis.	If pitch power unit (H) does not move, replace the attitude reference control.
		If pitch power unit (H) moves, check roll beep switch both ways, right and left.	If operation is improper both ways, replace the attitude reference control.
			If operation is improper in just one way, replace the pitch control (beep switch).
8	Large roll transients	Check for varying voltage at W1P22–X (0 to 10 vdc) with beep switch operating.	For no voltage, replace attitude reference control.
			Voltage present, replace roll power unit (H) and then attitude reference control.

Item No.	Symptom	Functional tests	Corrective measures
9	LOC, VOR, or NAV position of LATERAL engage switch inoperative.	Check that appropriate receiver is on.	Replace the navigational coupler. Check appropriate receiver. If trouble continues, replace attitude reference control.
10	HDG position of LATERAL engage switch inoperative.	Perform test in item No. 9 for navigational aid failure.	Check navigational aid.
11	Improper heading stabilization.	Verify that the compass system sensor signal is reliable and induce a signal from the force link by manually pressing the rudder pedal. Check for a changing voltage (0 to 10 vdc) at W1P22–W.	If changing voltage appears, replace yaw power unit (H). If no voltage change appears, replace attitude reference control.
12	No turn coordination		Replace the accelerometer. If trouble persists after next flight, replace yaw power unit (H).
13	Large heading transient	Repeat item No. 11.	
14	Altitude hold inoperative	With system engaged and VERTICAL engage switch (altitude) engaged, manually pull up on collective pitch control stick. Check for a voltage change (0 to 2 vdc) at W1P22–C.	If no voltage change appears, replace collective pitch power unit.
		If a voltage change occurs, disconnect the static line connector to the altitude control and replace with a rubber hose. With a rubber bulb or orally, make a small change in the pressure in the altitude control.	Check for a voltage change (0 to 2 vdc) at W1P22–B. If no voltage change appears, replace altitude control. If a voltage change occurs, replace navigational coupler.
15	Altitude command inoperative.	With AUTO PILOT engage switch (attitude) and VERTICAL engage switch (altitude) engaged, manually, pull up on collective pitch control stick.	Check for a voltage change (0 to 2 vdc) at W1P22–Z. If no voltage change occurs, replace collective pitch command control. If a voltage change occurs, replace collective pitch power unit.
16	Large collective pitch transient.		Replace collective pitch power unit and/or collective pitch command control.
17	RADAR altitude hold or GLIDE PATH inoperative.	With VERTICAL select switch in APP or RAD position, check to see that appropriate receiver is ON. Place VERTICAL select switch in BAR position and engage VERTICAL engage switch (altitude); manually pull up on collective pitch control stick.	Check for a voltage change (0 to 2 vdc) at W1P22–Z. If no voltage change occurs, replace collective pitch command control. If a voltage change occurs, replace navigational coupler, check glide slope, or radar altimeter receiver.
18	Rpm control inoperative	After 2½ minutes of system operation (power on), check for operation of the rpm switch.	If the rpm control switch does not engage, replace rpm control switch. If the switch engages, replace rpm power unit.

81. General

Removal and replacement instructions for the components listed below are identical with those for fixed-wing installations. Refer to the paragraph listed.

Component	Removal (para)	Replacement (para)
Accelerometer	64	65
Altitude controller	66	67
Attitude reference control	68	69
Vertical gyro	72	73
Navigational coupler	74	75

82. Removal of Actuator, Electro-Mechanical, Rotary, Flexible Shaft (Pitch and Roll), Yaw, and Collective Pitch; Actuator, Electro-Mechanical Rotary, Rpm

(fig. 6 or 8)

Remove the pitch, roll, and yaw power units (H), and the collective pitch and rpm power units as follows:

a. Disconnect the electrical connector.

b. Loosen the four captive screws at the slanting break in the case that holds the servodrive assembly to the drum and bracket assembly or flexible shaft and bracket assembly. (These screws are readily apparent when the power unit is viewed from above.)

c. Lift up on the servodrive assembly to remove it from drum and bracket assembly or the flexible shaft and bracket assembly.

d. Remove the four screws (fig. 27), and four washers; remove the calibration card from the power unit.

Note. The drum and bracket assembly or the flexible shaft and bracket assembly are not removed.

83. Replacement of Actuator, Electro-Mechanical Rotary, Flexible Shaft (Pitch and Roll), Yaw and Collective Pitch; Actuator, Electro-Mechanical Rotary, Rpm

Replace the pitch, roll, and yaw power units (H), and the collective pitch and rpm power units as follows:

a. Replace the servodrive assembly on the drum and bracket assembly or the flexible shaft and bracket assembly (fig. 6 or 8).

b. Tighten the four captive screws at the slanting break in the case.

c. Connect the electrical connector.

d. Replace the calibration card on the power unit (fig. 27).

e. Replace the four washers and tighten the four screws.

Note. When a new calibration card is supplied, compare the part numbers on the old and the new cards to be sure the parts are the same.

f. Record the hours of operation.

84. Removal of Actuator, Mechanical, Linear, Pitch or Roll

(fig. 29)

Remove the pitch and roll differentials as follows:

a. Disconnect the drive shaft adapter elbow (optional) if it is used. If it is not used, disconnect the flexible drive shaft.

b. Remove the two cotter pins, locknuts, mounting bolts, and four flat washers that connect the rod end bearings to the aircraft primary control linkage.

c. Remove the pitch and roll differential.

85. Replacement of Actuator, Mechanical, Linear, Pitch or Roll

(fig. 29)

Replace the pitch and roll differentials as follows:

a. Align the pitch or roll differential rod end bearings with the aircraft primary control linkage.

b. Connect the rod end bearings to the aircraft primary control linkage by replacing the two mounting bolts, locknuts, cotter pins and four flat washers.

Note. Observe that the pitch or roll differential is in the center of its travel before continuing with the replacement procedure.

c. Connect the drive shaft adapter elbow (optional) if it is used. If it is not used, connect the flexible drive shaft.

d. Record the hours of operation.

86. Removal of Control, Command, Collective Pitch

(fig. 13)

a. Disconnect electrical connector J1.

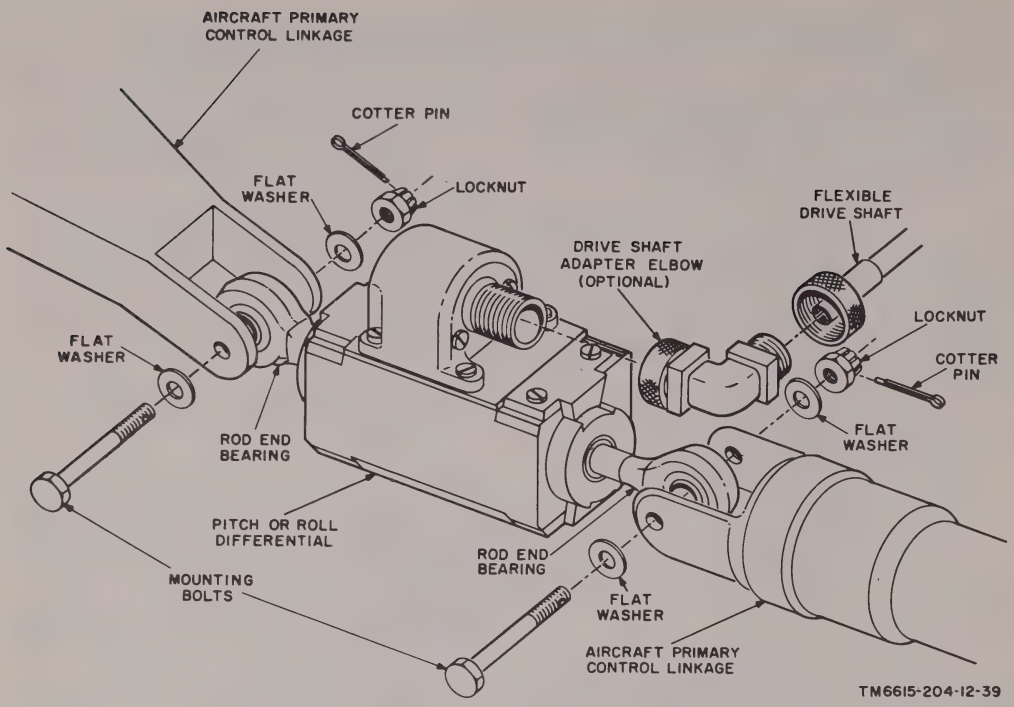

Figure 29. Typical pitch or roll differential installation.

b. Remove the four mounting screws.

c. Remove the collective pitch command control.

87. Replacement of Control, Command, Collective Pitch

(fig. 13)

a. Place the new collective pitch command control in position and secure with the four mounting screws.

b. Reconnect the electrical connector J1.

c. Record the hours of operation.

88. Removal of Switch, Control, Rpm

(fig. 14)

a. Remove the two mounting nuts and the lockwasher.

b. Remove the rpm control switch from the bracket.

c. Disconnect the electrical connector (not shown) and remove the rpm control switch.

89. Replacement of Switch, Control, Rpm

(fig. 14)

a. Connect the electrical connector (not shown) to the new rpm control switch.

b. Insert the rpm control switch into the bracket and secure it with the lockwasher and the two mounting nuts.

c. Record the hours of operation.

90. Removal of Transducer, Rotary Motion, Rpm

(fig. 18)

Remove the command pickoff as follows:

a. Disconnect the electrical connector (J1).

b. Disconnect the drive shaft coupling.

c. Disconnect the three mounting screws from the mounting holes and remove the unit.

91. Replacement of Transducer, Rotary Motion, Rpm

(fig. 18)

Replace the command pickoff as follows:

a. Place the new unit in position and secure with the three mounting screws.

b. Connect the drive shaft coupling.

c. Connect the electrical connector (J1).

d. Align the command pickoff electrically relative to the collective pitch control stick as follows:

(1) Loosen the drive shaft coupling locking screw.

(2) Insert Multimeter TS–297/U test prods between test point J3 (blue) and J4 (red) (fig. 18).

(3) With the collective pitch control stick fully down, and the system energized, rotate the command pickoff shaft until 0.5 volt dc is obtained.

(4) Lock the drive shaft coupling by tightening the drive shaft coupling locking screw.

(5) Raise the collective pitch control stick until the meter indicates 6.5 volts dc (0-50 volt scale). Lock the collective pitch control stick in place.

(6) Loosen the drive shaft coupling locking screw and rotate the command pickoff drive shaft until the meter indicates 0.5 volt dc (0-10 volt scale).

(7) Lock the drive shaft coupling by tightening the drive shaft coupling locking screw.

e. Record the hours of operation.

CHAPTER 7

DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

92. Authority for Demolition

Demolition of the equipment will be accomplished only upon the order of the commander. The destruction procedures outlined in paragraph 93 will be used to prevent further use of the equipment.

93. Method of Destruction

Use any of the following methods to destroy the equipment.

a. Smash. Smash the controls, tubes or transistors, coils, switches, capacitors, transformers, timers, meters and indicators; use sledges, axes, handaxes, pickaxes, hammers or crowbars.

b. Cut. Cut the input, output, and power cables; use axes, machetes, handaxes, or other sharp-edged tools.

c. Burn. Burn cords, cables, technical manuals, diagrams, and forms; use gasoline, kerosene, oil, incendiary grenades, or flamethrowers.

d. Bend. Bend panels, cabinets, and chassis.

e. Explode. If explosives are necessary, use small arms, grenades, or TNT.

f. Dispose. Bury or scatter the destroyed parts in slit trenches, foxholes, or throw them into streams; bury or scatter over as wide an area as possible.

APPENDIX I

REFERENCES

TM 1–250	Principles of Fixed Wing Flight.
TM 1–260	Principles of Rotary Wing Flight.
TM 11–5500	Multimeter TS–297/U.
TM 11–5826–200–12	Radio Receiver R–746/AR; Operation and Organizational Maintenance.
TM 11–5826–204–12	Operation and Organizational Maintenance: Direction Finder Set AN/ARN–59.
TM 11–5826–207–10	Operator's Manual: Radio Receiving Sets AN/ARN–30A, AN/ARN–30B, and AN/ARN–30C.
TM 11–5841–216–10	Operator's Manual: Radar Set AN/APN–22.
TM 11–5841–217–12	Navigation Set, Radar AN/APN–129(V).

APPENDIX II

MAINTENANCE ALLOCATION FOR AUTOMATIC FLIGHT CONTROL SYSTEM AN/ASW-12 (V)

Section I. INTRODUCTION

1. General

a. Scope. The maintenance allocation portion of this manual assigns maintenance functions and repair operations to be performed by the lowest appropriate maintenance echelon. It also specifies the tool and test equipments authorized at each echelon to perform the assigned maintenance functions.

b. Maintenance Allocation Chart Columns. Columns in the maintenance allocation chart are as follows:

(1) *Part or component.* This column shows only the nomenclature or standard item name. Additional descriptive data are included only where clarification is necessary to identify the part.

(2) *Maintenance function.* This column indicates the various maintenance functions allocated to the echelon capable of performing the operations. These are as follows:

(a) Service. To clean and to preserve.

(b) Adjust. To regulate periodically to prevent malfunction.

(c) Inspect. To verify serviceability and to detect incipient electrical or mechanical failure by scrutiny.

(d) Test. To verify serviceability and to detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, etc.

(e) Replace. To substitute serviceable assemblies, subassemblies, and parts for unserviceable components.

(f) Repair. "Repair" as listed in this maintenance allocation chart is defined as a refurbishing operation, such as painting, straightening, or similar mechanical operations.

(g) Align. To adjust two or more components of an electrical system so that their functions are properly synchronized.

(h) Calibrate. To determine, check, or rectify the graduation of an instrument, weapon, or weapons system, or components of a weapons system.

(i) Rebuild. To restore to a condition comparable to new by disassembling the item to determine the condition of its component parts and reassembling it with serviceable, rebuilt, or new assemblies, subassemblies, and parts.

(3) *1st, 2d, 3d, 4th, 5th echelon.* The symbol X placed in any of these columns indicates the echelon responsible for performing that particular maintenance operation, but does not necessarily indicate that repair parts will be stocked at that level. Echelons higher than the echelon indicated are authorized to perform the maintenance function.

(4) *Tools required.* This column indicates codes assigned to each individual tool equipment, test equipment, and maintenance equipment referenced. The grouping of codes in this column indicate the tool, test, and maintenance equipment required to perform the maintenance function.

(5) This column contains any notation necessary to clarify the data cited in the preceding columns.

c. Allocation of Tools for Maintenance Functions. Columns in the allocation of tools for maintenance functions are as follows:

(1) *Tools required for maintenance functions.* This column lists the tool and test equipments required to perform the maintenance functions.

(2) *1st, 2d, 3d, 4th, 5th echelon.* A dagger (†) indicates that the tool or test equipment is allocated to that echelon.
(3) *Tool code.* The numbers in this column are code numbers that stand for the associated tool or test equipment and are used in the maintenance allocation chart to refer to the indicated item.
(4) *Remarks.* This column contains any notations necessary to clarify the data cited in the preceding columns.

2. Maintenance by Using Organizations

When this equipment is used by signal service organizations organic to theater headquarters or communication zones to provide theater communications, those maintenance functions allocated up to and including fourth echelon are authorized to the organization operating this equipment.

3. Mounting Hardware

The basic entries of the maintenance allocation chart do not include mounting hardware such as screws, nuts, bolts, washers, brackets, and clamps.

4. Test Requirements

In situations where test equipments, not authorized to second echelon maintenance personnel, are required to isolate malfunctioning *black box* components within the aircraft prior to removal, third echelon Signal maintenance personnel will, upon request, assist in performing the required test.

Section II. MAINTENANCE ALLOCATION CHART

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH	(4) 2ND ECH	(5) 3RD ECH	(6) 4TH ECH.	(7) 5TH ECH	(8) TOOLS REQUIRED	(9) REMARKS
AUTOMATIC FLIGHT CONTROL SYSTEM AN/ASW-12(V)								
	service		X					
	adjust	X					1	Pilot
			X				37, 2, 16, 8, 10	
	inspect	X						Pilot-Operator
			X				37, 2	
	test		X				37, 2, 16	For Depot (5th) Echelon additional code
				X			1, 3, 4, 10, 8, 13, 14, 15, 17, 23, 49, 30, 9	
					X		1, 3, 4, 5, 6, 7, 9, 11, 12, 14, 15, 17, 30	
	test					X	1, 3, 4, 5, 6, 7, 9, 11, 12, 15, 17, 30, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 31, 32, 33, 34, 35, 36	
	replace		X				37, 2	
	repair				X		9	
	align							Factory alignment calibration Cord
	calibrate							Factory calibration calibration Cord
	rebuild					X		
SECTION "A" COMPONENTS USED IN BOTH "FIXED" AND "ROTARY" WING AIRCRAFT								
ACCELEROMETER, AIRCRAFT MX-2916/ASW-12(v)	service		X					
	inspect	X						Pilot-Operator
			X				37, 2	
	test		X				37, 2, 8, 10, 16	
				X			1, 3, 4, 13, 14, 8, 10	
					X		1, 3, 4, 14	
	replace		X				37, 2	See note 4
	repair				X			Recommend, Contractor repair
	rebuild					X	9	

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
CLAMP, LOOP	replace			X				
CONNECTOR	replace			X				
COVER	replace			X				Fabricate at 5th
DEMODULATOR, LINEAR ACCELEROMETER	replace			X				
BOARD, PRINTED CIRCUIT	replace					X		
CAPACITOR	replace			X				
RESISTOR	replace			X				
SEMI-CONDUCTOR	replace			X				
GROMMET	replace			X				
HOUSING	replace					X		
INSULATOR	replace			X				
JACK, TIP	replace					X		
LEAD, ELECTRICAL	replace			X				
TERMINAL LUG	replace			X				
LINEAR ACCELEROMETER SUB-ASSEMBLY	replace					X		Maintained at 5th echelon
ARMATURE, INDUCTANCE COIL	replace					X		
BELLOWS ASSEMBLY	replace					X		
CLIP, SPRING	replace					X		
COVER, SUPPORT	replace					X		
ELEMENT ASSEMBLY	replace					X		
LAMINATION ASSEMBLY	replace					X		
CYCLEWELD ASSEMBLY	replace					X		
FOOT, LEFT	replace					X		
FOOT, RIGHT	replace					X		
SPRING, RETAINING	replace					X		
PLATE MOUNTING	replace					X		
SEAL, COVER	replace					X		
SPRING	replace					X		
STOP, ADJUSTABLE	replace					X		
SUPPORT ARM	replace					X		
TRANSFORMER ASSEMBLY	replace					X		
COIL ASSEMBLY	replace					X		
PINCHOFF ASSEMBLY	replace					X		
PLATE, IDENTIFICATION	replace					X		Fabricate at 5th
TERMINAL	replace			X				

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
ACTUATOR, ELECTRO-MECHANICAL, ROTARY TG-78/ASW-12(V); TG-79/ASW-12(V); TG-80/ASW-12(V)	service		X					
	adjust			X			9, 23	
	inspect	X						Pilot
			X				37, 2	
	test		X				37, 2	
				X			1, 3, 4, 8, 9, 10, 13, 14, 23, 29	
					X		1, 3, 4, 5, 7, 14, 23, 29, 9, 6, 11, 12	
						X	1, 3, 4, 5, 7, 23, 29, 9, 6, 11, 12	
	replace		X				37, 2	See note 4 (Base of Actuator is not replaceable) will be maintained by T.C.
	repair				X		9	
	calibrate							Calibration Cord is Factory Aligned
	rebuild					X		
ACTUATOR, ELECTRO-MECHANICAL, ROTARY TG-79/ASW-12(V)	service		X					
	adjust			X			9, 23	
	inspect	X						Pilot
			X				37, 2	
	test		X				37, 2	
				X			1, 3, 4, 8, 9, 10, 13, 14, 23, 29	
					X		1, 3, 4, 5, 7, 14, 23, 29, 9	
						X	1, 314, 5, 7, 23 29, 9, 6, 11, 12	
	replace		X				37, 2	See note 4 (Base of Actuator is not replaceable)
	repair				X		9	
	rebuild					X		

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
ACTUATOR, ELECTRO-MECHANICAL, ROTARY TG-80/ASW-12(V)	service		X					
	adjust			X			9, 23	
	inspect	X						Pilot
			X				37, 2	
	test		X				37, 2	
				X			1, 3, 4, 8, 9, 10, 13, 14, 23, 29	
					X		1, 3, 4, 5, 7, 14, 23, 29, 9	
						X	1, 3, 4, 5, 7, 23, 29, 9, 6, 11, 12	
	replace		X				37, 2	See note 4 (Base of Actuator is not replaceable
	repair				X		9	
	rebuild					X		
AMPLIFIER ASSEMBLY	replace			X				
BOARD ASSEMBLY	replace			X				
BOARD CIRCUIT	replace					X		
CAPACITOR	replace			X				
RESISTOR	replace			X				
SEMI-CONDUCTOR	replace			X				
BOARD, CIRCUIT	replace			X				
BOARD ASSEMBLY	replace					X		
HOLDER, SEMI-CONDUCTOR	replace					X		
CAPACITOR	replace			X				
RESISTOR	replace			X				
SEMI-CONDUCTOR	replace			X				
THERMISTOR	replace			X				
TRANSFORMER	replace			X				
TRANSISTOR	replace			X				
BRACKET	replace					X		
CHASSIS ASSEMBLY	replace			X				
CHASSIS, AMPLIFIER	replace					X		
INSULATOR	replace					X		
JACK, TIP	replace			X				
LUG, THREADED	replace					X		
RESISTOR	replace			X				

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
SLEEVE, HEADED	replace					X		
THERMINAL	replace			X				
TRANSFORMER	replace			X				
TRANSISTOR	replace			X				
CONNECTOR	replace			X				
COVER, AMPLIFIER	replace					X		
JACK, TIP	replace			X				
PLATE, IDENTICATION	replace					X		
STUD, MOUNTING	replace				X			
DRUM BRACKET	replace			X				
BEARING, BALL	replace				X			
BRACKET ASSEMBLY	replace			X				
HOUSING, DRUM	replace			X				
PIN, STRAIGHT	replace				X			
SPACER, DRUM	replace					X		
DRUM, CABLE	replace			X				
GEAR ASSEMBLY, DRIVE	replace				X			
PIN, SHEAR	replace				X			
GEAR, SPUR	replace				X			
KEY, MACHINE	replace					X		
PLATE, IDENTIFICATION	replace					X		
RING, RETAINING	replace					X		
RING, RETAINING	replace			X				
SHAFT, DRUM	replace					X		
PLATE, IDENTIFICATION	replace					X		
SERVO DRIVE ASSEMBLY	replace				X			
ADAPTER, SERVO	replace					X		
BEARING, BALL	replace				X			
CLEAT, MOUNTING	replace					X		
CLUTCH, MAGNETIC	replace				X			
CONNECTOR	replace				X			
GEAR ASSEMBLY, DRIVE	replace				X			
GEAR, PINION	replace				X			
GEAR, SERVO DRIVE	replace				X			
GEAR, SPUR	replace				X			
HOUSING ASSEMBLY	replace					X		
HOUSING	replace					X		

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
KEY, MACHINE	replace					X		
MOTOR, SERVO								
PIN, SPRING	replace				X			
PLATE, IDENTICATION	replace					X		
RESISTOR ASSEMBLY	replace				X			
RETAINER, CLUTCH	replace					X		
RING, RETAINING	replace				X			
SCREW, SERVO	replace				X			
SEMI-CONDUCTOR	replace				X			
SHAFT, INSTURMENT	replace					X		
SHAFT, SERVO DRIVE	replace					X		
SHIM	replace					X		
SPACER, CLUTCH	replace					X		
SPACER, INSTRUMENT	replace					X		
GEAR ASSEMBLY	replace				X			
PIN, DIAMOND	replace				X			
PIN, SPRING	replace				X			
PIN, STRAIGHT	replace				X			
RESISTOR, VARIABLE	replace				X			
GEAR ASSEMBLY	replace				X			
GEAR CARRIER	replace				X			
RING, RETAINING	replace				X			
SPRING	replace				X			

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
ACTUATOR, ELECTRO-MECHANICAL, ROTARY	service		X					
TG-81/ASW-12(V)	adjust			X			9, 23	
	inspect	X						Pilot
			X				37, 2	
			X				37, 2	
				X			1, 3, 4, 8, 9, 10, 13, 14, 23, 29	
				X			1, 2, 4, 5, 7, 14, 23, 29, 9, 6, 11, 12	
						X	1, 3, 4, 5, 7, 23, 29, 9, 6, 11, 12	
	replace		X				37, 2	See note 4 (Base of Actuator is not replaceable. Maintained by T.C.)
	repair				X		9	
	calibrate							Calibration Cord is Factory aligned
	rebuild					X		
DRUM ASSEMBLY	replace			X				
BEARING, BALL	replace			X				
DRUM, CABLE	replace			X				
GEAR ASSEMBLY	replace				X			
GEAR	replace				X			
PIN, SHEAR	replace				X			
RING, RETAINING	replace				X			
SHAFT, DRUM	replace					X		
HOUSING ASSEMBLY	replace			X				
DRUM, HOUSING	replace			X				
PIN, STRAIGHT	replace			X				
SPACER, BEARING	replace					X		
KEY, MACHINE	replace					X		
PLATE, IDENTIFICATION	replace					X		
RING, RETAINING	replace				X			
PLATE, IDENTIFICATION	replace					X		
SERVO DRIVE ASSEMBLY	replace			X				
BEARING	replace				X			
BEARING, BALL	replace			X				
BEARING, BALL	replace				X			
CARRIER, CLUTCH	replace				X			

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
CLUTCH, MAGNETIC	replace				X			
CONNECTOR	replace				X			
COVER	replace					X		
DIFFERENTIAL	replace			X				
ACTUATOR, SWITCH	replace					X		
BEARING, BALL	replace			X				
GEAR	replace				X			
HOUSING, DIFFERENTIAL	replace					X		
HOUSING, SERVO	replace				X			
INSULATOR, STANDOFF	replace			X				
NUT, ADJUSTING	replace			X				
PIN, STRAIGHT	replace			X				
PLATE, SWITCH	replace					X		
RING, RETAINING	replace				X			
RING, RETAINING	replace					X		
SCREW, DIFFENTIAL	replace				X			
SEMI-CONDUCTOR	replace			X				
SPACER, BEARING	replace					X		
SPRING, TAKE-UP	replace			X				
SWITCH	replace			X				
THIMBLE	replace					X		
DOG, CLUTCH	replace					X		
GEAR	replace				X			
KEY, MACHINE	replace					X		
NUT ASSEMBLY, ADJUST	replace				X			
PIN, KEEPER	replace				X			
NUT, ADJUSTING	replace				X			
MOTOR	replace			X				Maintain at 5th
OILER, CLUTCH	replace					X		
PIN, SPRING	replace				X			
PIN, STRAIGHT	replace			X				
PINION, DRUM	replace			X				
PLATE, IDENTIFICATION	replace					X		
PLATE, TERMINAL	replace					X		
RING, RETAINING	replace			X				
RING, RETAINING	replace				X			
SCREW, TIE DOWN	replace			X				

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
SEMI-CONDUCTOR	replace			X				
SHAFT, GEAR	replace				X			
SPACER, CLUTCH	replace					X		
SPACER, PINION	replace					X		
SPACER, SLEEVE	replace					X		
SPRING, BELLEVIL	replace				X			
SPRING, BELLEVIL	replace				X			
SPRING, HELICAL	replace				X			
STUD, GEAR	replace				X			
TERMINAL, STANDOFF	replace			X				
CALIBRATION UNIT MX-2917/ASW-12(V);	service		X					
MX-2918/ASW-12(V); MX-2919/ASW-12(V)	inspect		X				37, 2	
	test		X				37, 2	
				X			1, 3, 4, 13, 8, 10	Use codes 11 and 12 at 4th echelon
	replace		X				37, 2	See note 4
	repair				X		9	
	calibrate							Factory aligned
	rebuild					X		
CALIBRATION CARD ASSEMBLY	replace			X				
BRACKET	replace				X			
CAPACITOR	replace			X				
RESISTOR	replace			X				
TERMINAL STANDOFF	replace			X				
WIRING ASSEMBLY	replace			X				
CONNECTOR	replace			X				
COVER, PLATE	replace			X				Fabricate at 5th
PLATE, IDENTIFICATION	replace					X		
CONTROL, ALTITUDE, AUTOMATIC PILOT C-3106/ASW-12(V)	service		X					
	inspect		X				37, 2	
	test		X				37, 2, 16	
				X			1, 3, 4, 13, 14, 9, 16	
					X		1, 3, 4, 13, 14, 12, 6, 11, 5, 7, 9, 28, 22	
	replace		X				37, 2	See note 4
	repair				X		9	
	rebuild					X		

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
BRACKET	replace					X		
CHASSIS	replace					X		
CONNECTOR	replace			X				
CONTROL ASSEMBLY	replace					X		Maintained at 5th
ADJUSTMENT ASSEMBLY	replace					X		
CLAMP, SPRING	replace					X		
PLATE	replace					X		
PLATE, LOCK	replace					X		
SHIM	replace					X		
SPACER	replace					X		
SPRING	replace					X		
ARM ASSEMBLY	replace					X		
ARM	replace					X		
CLAMP	replace					X		
CONE	replace					X		
SPRING	replace					X		
BAR ASSEMBLY	replace					X		
ARM	replace					X		
BAR	replace					X		
CLAMP	replace					X		
SPRING	replace					X		
BLOCK, MOUNT	replace					X		
BRACKET	replace					X		
BRACKET ASSEMBLY	replace					X		
BRACKET	replace					X		
HINGE	replace					X		
PLATE	replace					X		
SADDLE	replace					X		
SPRING	replace					X		
BRACKET, DAMPER	replace					X		
CAP ASSEMBLY	replace					X		
CARRIER ASSEMBLY	replace					X		
ARMATURE, INDUCTANCE	replace					X		
CARRIER	replace					X		
GASKET	replace					X		
PLATE	replace					X		
SHIM	replace					X		

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
SPRING	replace					X		
CASE	replace					X		
CLAMP	replace					X		
CLIP, WIRE	replace					X		
COVER	replace			X				
DAMPER ASSEMBLY	replace					X		
ARM, DAMPER	replace					X		
DECAL	replace					X		
EYELET ASSEMBLY	replace					X		
GASKET	replace					X		
LEVER ASSEMBLY	replace					X		
BRACKET	replace					X		
CLAMP	replace					X		
CLUTCH ASSEMBLY	replace					X		
INSERT	replace					X		
JAW ASSEMBLY	replace					X		
JAW, FIXED	replace					X		
LEVER	replace					X		
PIN, STRAIGHT	replace					X		
PLATE	replace					X		
SPRING	replace					X		
PIN, STRAIGHT	replace					X		
PLATE	replace					X		
PLUNGER ASSEMBLY	replace					X		
LINK	replace					X		
PIN	replace					X		
PLUNGER	replace					X		
POST, DAMPER	replace					X		
SCREW, ADJUSTING	replace					X		
SOLENOID ASSEMBLY	replace					X		
SHIM	replace					X		
SPACER	replace					X		
SPRING	replace					X		
STUD	replace					X		
TERMINAL ASSEMBLY	replace					X		
TERMINAL	replace					X		
TRANSFORMER ASSEMBLY	replace					X		

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
WEIGHT	replace					X		
WEIGHT, COUNTER	replace					X		
WIRING HARNESS	replace					X		
COVER, ELECTRICAL CONNECTOR	replace					X		
DEMODULATOR	replace			X				
CAPACITOR	replace			X				
RESISTOR	replace			X				
SEMI-CONDUCTOR	replace			X				
TERMINAL BOARD	replace					X		
TERMINAL STANDOFF	replace			X				
GROMMET	replace			X				
JACK, TIP	replace			X				
PACKING, PREFORMED	replace			X				
PLATE, IDENTIFICATION	replace					X		
PLUG, PIPE	replace			X				
RELAY	replace			X				
TRANSFORMER	replace			X				
TUBE ASSEMBLY	replace			X				
TUBING	replace			X				
SCREW	replace			X				
CONTROL ATTITUDE, REFERENCE C-3108/ASW-12(V)	service		X					
	inspect	X						Pilot
			X				37, 2	
	test		X				37, 2	
				X			1, 3, 4, 13, 14, 9	
					X		1, 3, 4, 5, 6, 7, 11, 12, 14, 9	
						X	1, 3, 4, 5, 6, 7, 11, 12, 22, 26, 32, 9	
	replace		X				9	See note 4
	repair				X		37, 2	
	rebuild					X		
BAR, RETAINING	replace					X		
BLOWER	replace			X				
BRACKET, CAPACITOR	replace					X		
BRACKET, POWER	replace					X		
BRACKET, RELAY	replace					X		

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH	(4) 2ND ECH.	(5) 3RD ECH	(6) 4TH ECH.	(7) 5TH ECH	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
CALIBRATION ASSEMBLY	replace			X				
CAPACITOR	replace			X				
PRINTED, CIRCUIT	replace					X		
RETAINER	replace					X		
CARD, TEST	replace					X		
CAPACITOR	replace			X				
CHASSIS	replace			X				
CLAMP, SERVO	replace					X		
CONNECTOR	replace			X				
COVER, BOTTOM	replace			X				
COVER, DUST	replace					X		
DEMODULATOR ASSEMBLY	replace			X				
BOARD CIRCUIT	replace					X		
BOARD	replace					X		
RESISTOR	replace			X				
BOARD, MOUNTING	replace					X		
POST, THREADED	replace					X		
SPACER	replace					X		
TERMINAL, STANDOFF	replace			X				
TRANSFORMER	replace			X				
GROMMET, RUBBER	replace			X				
INDICATOR, TIME	replace			X				
JACK, TIP	replace			X				
MODULATOR ASSEMBLY	replace			X				
BRACKET ASSEMBLY	replace					X		
MODULATOR	replace			X				
RESISTOR	replace			X				
SEMI-CONDUCTOR	replace			X				
PRINTED CIRCUIT	replace					X		
MOTOR, GENERATOR ASSEMBLY	replace			X				
CONNECTOR	replace			X				
MOTOR, GENERATOR, GEAR TRAIN, SYNCHRO AND POTENTIOMETER ASSEMBLY	replace							Maintain at 5th
PAD, HEAT SINK	replace					X		
PLATE, IDENTIFICATION	replace					X		
PLATE, REAR	replace					X		
RELAY, MINIATURE	replace			X				

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
RESISTOR	replace			X				
RETAINER	replace					X		
RETAINER ASSEMBLY	replace					X		
SEMI-CONDUCTOR	replace			X				
SPACER	replace					X		
SYNCHRO, AMPLIFIER ASSEMBLY	replace			X				
BOARD ASSEMBLY	replace					X		
BOARD, CIRCUIT	replace					X		
SPACER	replace					X		
BOARD, CIRCUIT	replace					X		
RESISTOR	replace			X				
TRANSISTOR	replace				X			
CAPACITOR	replace			X				
INSULATOR	replace					X		
PAD, HEAT SINK	replace					X		
TRANSFORMER	replace			X				
RESISTOR	replace			X				
TRANSISTOR	replace			X				
BOARD CIRCUIT	replace					X		
HOLDER, SEMI-CONDUCTOR	replace					X		
TERMINAL	replace			X				
TRANSFORMER	replace			X				
TRANSISTOR	replace			X				
CONTROLLER, FLIGHT, AUTOMATIC PILOT	service		X					
C-3107/ASW-12(V)	adjust	X						Pilot
	inspect	X						Pilot
			X				37.2	
	test		X				37.2	
				X			1, 3, 4, 13, 14, 9	
						X	1, 3, 4, 5, 6, 7, 11, 12, 22, 37, 9	
	replace		X				9	See note 4
	repair				X		37.2	
	rebuild					X		
ACTUATOR ASSEMBLY	replace			X				
ACTUATOR SWITCH ASSEMBLY	replace					X		
ACTUATOR, SWITCH	replace					X		

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
BEARING, FLANGED	replace					X		
BASE ASSEMBLY, MOUNTING	replace					X		
BASE, MOUNTING	replace					X		
BEARING, FLANGED	replace					X		
BUSHING	replace					X		
CAM ASSEMBLY, FOLLOW	replace				X			
SPRING, FOLLOWER	replace					X		
GEAR	replace				X			
GEAR-CAM ASSEMBLY	replace				X			
PIN, STRAIGHT	replace				X			
INSULATOR	replace					X		
MICRO-SWITCH ASSEMBLY	replace				X			
ACTUATOR ASSEMBLY	replace				X			
INSULATOR, PLATE	replace					X		
SWITCH, SENSITIVE	replace				X			
PIN, SPRING	replace				X			
PLATE, BACKUP	replace					X		
PLATE, SPRING	replace					X		
PLUNGER, SPRING	replace				X			
RESISTOR	replace				X			
RING, RETAINING	replace				X			
SCREW, ADJUSTMENT	replace				X			
SHAFT, PIVOT	replace					X		
SHAFT, TURN	replace					X		
SWITCH, SENSITIVE	replace				X			
TERMINAL	replace				X			
WIRING ASSEMBLY	replace					X		
BRACKET, SWITCH ASSEMBLY	replace					X		
BRACKET, SWITCH	replace					X		
STUD, MICRO-SWITCH	replace					X		
BRACKET, ASSEMBLY	replace					X		
COVER ASSEMBLY	replace			X				
BOOT	replace			X				
CONNECTOR	replace			X				
COVER ASSEMBLY	replace					X		
COVER	replace					X		
GASKET	replace			X				

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH	(4) 2ND ECH	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
TERMINAL BOARD	replace					X		
PANEL	replace			X				
HOUSING ASSEMBLY	replace					X		
ADAPTER ASSEMBLY	replace				X			
PIN, STRAIGHT	replace				X			
BOARD ASSEMBLY, POWER	replace				X			
BOARD, POWER SUPPLY	replace				X			
CAPACITOR	replace				X			
RESISTOR, FIXED	replace				X			
SEMI-CONDUCTOR	replace				X			
CONNECTOR (26 cont)	replace				X			
GASKET	replace					X		
HOUSING ASSEMBLY	replace					X		
HOUSING	replace					X		
PLATE, BACK-UP	replace					X		
SPRING, COVER	replace					X		
JACK, TIP	replace				X			
PLATE, DUST COVER	replace					X		
RESISTOR	replace				X			
TRANSFORMER	replace				X			
JACK, TIP	replace			X				
KNOB	replace		X					
PLATE, IDENTIFICATION	replace					X		
RUBBER, CHANNEL	replace			X				
SERVO, EFFORT	replace			X				Maintain at 5th echelon
SPACER, COVER	replace					X		

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
COUPLER, NAVIGATIONAL CU-792/ASW-12(V)	service		X					
	adjust	X						Pilot
	inspect	X						Pilot
			X				37, 2	
	test		X				37, 2	
				X			1, 3, 9, 13, 14, 9	
					X		1, 3, 4, 5, 6, 7, 11, 12, 14, 9	
						X	1, 3, 4, 5, 6, 7, 11, 12, 22, 25, 31, 9	
	replace		X				9	See note 4
	repair				X		37, 2	
	rebuild					X		
BAR, RETAINING	replace					X		
BLOWER	replace			X				
BRACKET ASSEMBLY	replace					X		
BRACKET, MOUNTING	replace					X		
BRACKET, CLAMP	replace					X		
BUSHING, SLEEVE	replace					X		
CALIBRATION CARD ASSEMBLY, VERTICAL	replace			X				
CALIBRATION CARD	replace					X		
RESISTOR	replace			X				
TERMINAL	replace			X				
CAPACITOR	replace			X				
CHASSIS ASSEMBLY	replace					X		
RETAINER	replace					X		
RECEPTACLE	replace			X				
SPACER	replace					X		
CHANNEL, ASSEMBLY	replace			X				
BOARD ASSEMBLY, LATERAL AXIS CHANNEL	replace			X				
BOARD ASSEMBLY	replace			X				
HOLDER, SEMI-CONDUCTOR	replace					X		
CHANNEL ASSEMBLY	replace			X				
CHANNEL ASSEMBLY	replace			X				
BOARD CIRCUIT	replace					X		
HOLDER, SEMI-CONDUCTOR	replace					X		
CAPACITOR	replace			X				
RESISTOR	replace			X				

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
SEMI-CONDUCTOR	replace			X				
TRANSISTOR	replace			X				
BRACKET ASSEMBLY	replace					X		
CAPACITOR	replace			X				
CONNECTOR	replace			X				
INSULATOR	replace			X				
TRANSFORMER	replace			X				
CLIP	replace					X		
RETAINER	replace					X		
CONNECTOR	replace			X				
CAPACITOR	replace			X				
RESISTOR	replace			X				
SEMI-CONDUCTOR	replace			X				
TRANSISTOR	replace			X				
CAPACITOR	replace			X				
CONNECTOR	replace			X				
COVER, DUST	replace					X		
GROMMET	replace			X				
INSULATOR	replace			X				
JACK, TIP	replace			X				
KNOB, SELECTOR	replace			X				
PAD, HEAT SINK	replace					X		
PANEL ASSEMBLY FRONT	replace					X		
FASTENER, PANEL	replace			X				
RETAINER, RECEPTACLE	replace					X		
SPACER	replace					X		
PANEL, COUPLER	replace			X				
PLATE, IDENTIFICATION	replace					X		
POST	replace					X		
RELAY, MINIATURE	replace			X				
RESISTOR	replace			X				
SEMI-CONDUCTOR	replace			X				
SPACER	replace					X		
SWITCH, ROTARY	replace			X				
SWITCH, TOGGLE	replace			X				
SYNCHRO AMPLIFIER	replace			X				
BOARD ASSEMBLY	replace					X		

(1) TOOLS REQUIRED FOR MAINTENANCE FUNCTIONS		(2) 1ST ECH.	(3) 2ND ECH.	(4) 3RD ECH.	(5) 4TH ECH.	(6) 5TH ECH.	(7) TOOL CODE	(8) REMARKS
AN/ASW-12(V) (continued)								
BOARD CIRCUIT	replace					X		
BOARD CIRCUIT	replace					X		
BOARD CIRCUIT	replace					X		
HOLDER, SEMI-CONDUCTOR	replace					X		
RESISTOR	replace			X				
TRANSISTOR	replace			X				
CAPACITOR	replace			X				
INSULATOR	replace					X		
PAD, HEAT SINK	replace					X		
RESISTOR	replace			X				
TRANSFORMER	replace			X				
TRANSISTOR	replace			X				
TERMINAL	replace			X				
TRANSISTOR	replace			X				
TRANSFORMER	replace			X				
BRACKET ASSEMBLY	replace					X		
CAPACITOR	replace			X				
CLAMP, CASE	replace					X		
CONNECTOR	replace			X				
GROMMET	replace			X				
INSULATOR, STANDOFF	replace			X				
POST, THREADED	replace					X		
SERVO DRIVE ASSEMBLY	replace			X				
CONNECTOR	replace			X				
MOTOR TACHOMETER	replace			X				
STUD	replace			X				
TERMINAL	replace			X				
TRANSFORMER	replace			X				

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
GYROSCOPE, DISPLACEMENT CN-601/ASW-12(V)	service		X					
	inspect		X				37.2	
	test		X				37, 2, 10, 8	
				X			1, 3, 4, 13, 14,	
							9, 10, 8	
					X		1, 3, 4, 5, 6, 7,	
							11, 12, 14, 9	
						X	1, 3, 4, 5, 6, 7,	
							11, 12, 22, 18, 19, 20,	
							21, 35, 36	
	replace		X				9	See note 4
	repair				X		37, 2	
	rebuild					X		
CONTROL, UNIVERSAL	replace			X				
ADAPTER	replace				X			
BOARD, TERMINAL	replace				X			
CAPACITOR	replace				X			
CHASSIS ASSEMBLY	replace				X			
BASE, CHASSIS	replace				X			
CONNECTOR	replace				X			
CLAMP	replace				X			
COVER, GENERATOR	replace			X				
GROMMET, RUBBER	replace				X			
INDICATOR, POWER WARNING	replace				X			
PLATE, IDENTIFICATION	replace					X		
RELAY	replace				X			
RESISTOR	replace				X			
SEMI-CONDUCTOR	replace				X			
TERMINAL	replace				X			
TRANSFORMER	replace				X			
PLATE, IDENTIFICATION	replace					X		
VERTICAL GRYRO	replace			X				Maintained at 5th echelon

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
SECTION "B" COMPONENTS USED WITH ROTARY WING AIRCRAFT ONLY								
CONTROL, COMMAND, COLLECTIVE PITCH	service		X					
(HELICOPTER ONLY)	inspect		X				37	Exterior
				X			9	Interior
	test		X				2, 37	
				X			1, 2, 3, 4, 9, 13	
							14	
					X		1, 2, 3, 4, 9, 11	Use code 24 at 5th echelon
							13, 14, 20, 24	
	replace		X				37	See note
	repair			X			9	
	rebuild					X	9	
AMPLIFIER	inspect			X			9	
	replace			X			9	
	repair				X		9	
CHASSIS	rebuild					X		
INSTRUMENT SERVO	inspect			X			9	
	replace			X			9	
	repair				X		9	
POWER SUPPLY	inspect			X			9	
	replace			X			9	
	repair				X		9	
R:P.M. SENSOR (HELICOPTER ONLY)	inspect			X			9	
	replace			X			9	Hermetically sealed expendable item
TRIGGER AMPLIFIER	inspect			X			9	
	test				X		11	
	replace			X			9	
	repair				X		9	
FLEXIBLE SHAFT	replace							Maintained by Transportation personnel

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
AN/ASW-12(V) (continued)								
MECHANICAL LINEAR ACTUATOR	service		X					
(ROTARY WING AIRCRAFT ONLY)	inspect		X				37	Exterior
				X			9	Interior
	test		X				2, 37	
				X			1, 2, 3, 4, 6, 7, 13, 14, 15, 9	
					X	X	1, 2, 3, 4, 6, 7, 15, 9	
	replace		X				37	See note
	repair			X			9	
	rebuild					X	9	
R.P.M. SENSING NETWORK (HELICOPTER ONLY)	service		X					
	inspect		X					
	test		X				2, 37	
				X			1, 2, 13, 9, 33, 3, 4, 14	Use code 33 at 5th echelon
	replace		X				37	See note
	repair			X			9	
	rebuild					X	9	
CHASSIS	rebuild					X		
POWER SUPPLY	replace			X				
	repair				X			
TRANSDUCER, ROTARY MOTION (HELICOPTER ONLY)	service		X					
	inspect		X				37	Exterior
				X			9	Interior
	test		X				2, 37	
				X			1, 2, 3, 4, 13, 14	
					X		1, 2, 3, 4, 14, 17 34	Use code 34 at 5th echelon
	replace		X				37	Transducer case is non-expendable. See note

Section III. ALLOCATION OF TOOLS FOR MAINTENANCE FUNCTIONS

(1) TOOLS REQUIRED FOR MAINTENANCE FUNCTIONS	(2) 1ST ECH.	(3) 2ND ECH.	(4) 3RD ECH.	(5) 4TH ECH.	(6) 5TH ECH.	(7) TOOL CODE	(8) REMARKS
AN/ASW-12(V) (continued)							
ELECTRONIC MULTIMETER, TS-505/U			†	†	†	1	
MULTIMETER, TS-297/U		†				2	To be used until AN/URM-105 is available
MULTIMETER, TS-352/U			†	†	†	3	To be used until AN/URM-105 is available
MULTIMETER, METER ME-26/U			†	†	†	4	
OSCILLOSCOPE, OS-8A/U			†	†	†	5	
TEST SET, ELECTRICAL POWER TS-914/U				†	†	6	
GENERATOR, SIGNAL SG-298/U				†	†	7	
STOPWATCH 6645-719-8950		†	†			8	
TOOL EQUIPMENT TE-113			†	†	†	9	To be used until TK-88( )/U is available
PROTRACTOR 5210-541-4856		†	†			10	
METER, MILLEVAC MV-17C				†	†	11	To be standardized and Nomenclatured
TEST SET, TRANSISTOR TS-1100/U				†	†	12	In development
ANALYZER, FLIGHT LINE SPERRY 2592034			†			13	To be Standardized and Nomenclatured
BENCH TEST SET SPERRY 2592035			†	†		14	To be Standardized and Nomenclatured
FIXTURE, MECHANICAL LINEAR ACTUATOR, SPERRY 2592037			†	†	†	15	To be Standardized and Nomenclatured
PITOT STATIC TESTER, AF type MB-1		†				16	To be Standardized and Nomenclatured
FIXTURE, PILOTS FORCE TRANSDUCER SPERRY 2592038			†	†	†	17	To be Standardized and Nomenclatured
ANALYZER, VERTICAL GYRO, SPERRY 2592052					†	18	To be Standardized and Nomenclatured
FIXTURE, GYRO HOLDING SPERRY 2592039					†	19	To be Standardized and Nomenclatured
TILT TABLE SPERRY 100719					†	20	To be Standardized and Nomenclatured
SCORSBY SPERRY 100720					†	21	To be Standardized and Nomenclatured
PHASE SENSITIVE VOLTMETER SPERRY 1000308					†	22	To be Standardized and Nomenclatured
FIXTURE, ELECTRO-MECHANICAL ROTARY TORQUE TEST SPERRY 2592036			†	†	†	23	To be Standardized and Nomenclatured
TESTER, COLLECTIVE PITCH COMMAND CONTROL, Sperry 2592051					†	24	To be Standardized and Nomenclatured
TESTER, AUTO NAVIGATION COUPLER, SPERRY 2592041					†	25	To be Standardized and Nomenclatured
TESTER, CONTROL REFERENCE ATTITUDE SPERRY 2592045					†	26	To be Standardized and Nomenclatured
TESTER, CONTROLLER AUTO PILOT SPERRY 2592049					†	27	To be Standardized and Nomenclatured
ANALYZER, ALTITUDE CONTROL SPERRY 2592043					†	28	To be Standardized and Nomenclatured
TESTER, ELECTRO-MECHANICAL ROTARY ACTUATOR SPERRY 2592040			†	†	†	29	To be Standardized and Nomenclatured
TESTER, PILOT'S FORCE TRANSDUCER SPERRY 2592047			†	†	†	30	To be Standardized and Nomenclatured
TESTER, AUTO-NAVIGATION COUPLER SUB-ASSEMBLY SPERRY 2592042					†	31	To be Standardized and Nomenclatured
TESTER, ATTITUDE REFERENCE CONTROL SUB-ASSEMBLY SPERRY 2592046					†	32	To be Standardized and Nomenclatured
TESTER, R.P.M. SENSOR SPERRY 2592048					†	33	To be Standardized and Nomenclatured
TESTER, ROTARY MOTION TRANSDUCER SPERRY 2592050					†	34	To be Standardized and Nomenclatured
TESTER, VERTICAL GYRO ERECTION CONTROL MODULE SPERRY 2892054					†	35	To be Standardized and Nomenclatured
FIXTURE, VERTICAL GYRO SCORSBY ADAPTER SPERRY 2592055					†	36	To be Standardized and Nomenclatured
TOOL EQUIPMENT TE-41		†				37	To be used until TK-87/U is available

APPENDIX III

BASIC ISSUE ITEMS LIST FOR AUTOMATIC FLIGHT CONTROL SYSTEM AN/ASW 12(V)

Section I. INTRODUCTION

1. Scope

a. This appendix lists the items supplied for initial operation. The list includes the material issued as *part of* the major end item. End items of equipment are issued on the basis of allowances prescribed in equipment authorization tables and other documents that are a basis for requisitioning.

b. The column headings are as follows:

(1) *Source, maintenance and recoverability code.* Not used.

(2) *Federal stock number.* This column lists the 11-digit Federal stock number.

(3) *Designation by model.* Not used.

(4) *Description.* Nomenclature or the standard item name and brief identifying data for each item are listed in this column. When requisitioning, enter the nomenclature and description on the requisition.

(5) *Unit of Issue.* The unit of issue is the supply term by which the individual item is counted for procurement, storage, requisitioning, allowances, and issue purposes.

(6) *Expendability.* Expendable items are indicated by the letter X; nonexpendable items are indicated by NX.

(7) *Quantity authorized.* Under "Items Comprising an Operable Equipment," the column lists the quantity of items supplied for the initial operation of the equipment. Under " Running Spares and Accessory Items" the quantities listed are those issued initially with the equipment as spare parts. The quantities are authorized to be kept on hand by the operator for maintenance of the equipment.

(8) *Illustration.* Not used.

2. Critical Items

A zero slash (ϕ) in the "Description" column indicates items that are expected to fail during the first year; also items that will make the equipment inoperative if they fail.

3. Comments or Suggestions

Any comments concerning omissions and discrepancies in this part of the manual will be prepared on DA Form 2028 and forwarded direct to the Commanding Officer, U. S. Army Signal Materiel Support Agency, ATTN: SIGMS/MLM, Fort Monmouth, N. J.

Section II. FUNCTIONAL PARTS LIST

(1) SOURCE MAINTENANCE AND RECOVERABILITY CODE	(2) FEDERAL STOCK NUMBER	(3) DESIGNATION BY MODEL	(4) DESCRIPTION	(5) UNIT OF ISSUE	(6) EXPENDABILITY	(7) QUANTITY AUTHORIZED	(8) ILLUSTRATIONS FIGURE NO.	(9) ILLUSTRATIONS ITEM NO
			ITEMS COMPRISING AN OPERABLE EQUIPMENT					
			AUTOMATIC FLIGHT CONTROL SYSTEM AN/ASW-12 (V)					
	6615-771-4633		AUTOMATIC FLIGHT CONTROL SYSTEM AN/ASW-12 (V) (0)	ea	NX			
	6615-771-4635		ACCELEROMETER, AIRCRAFT MX-2916/ASW-12 (V) (0)	ea	NX	1		
	1680-753-3972		ACTUATOR, ELECTRO-MECHANICAL, ROTARY TG-78/ASW-12 (V) (0)	ea	NX	1		
	1680-805-3975		ACTUATOR, ELECTRO-MECHANICAL, ROTARY TG-79/ASW-12 (V) (0)	ea	NX	1		
	1680-753-3972		ACTUATOR, ELECTRO-MECHANICAL, ROTARY TG-80/ASW-12 (V) (0)	ea	X	1		
	1680-805-3991		ACTUATOR, ELECTRO-MECHANICAL, ROTARY TG-81/ASW-12 (V)	ea	NX	1		
	6615-771-4638		CALIBRATION UNIT MX-2917/ASW-12 (V) (0)	ea	NX	1		
	6615-771-4639		CALIBRATION UNIT MX-2918/ASW-12 (V)	ea	NX	1		
	6615-771-4640		CALIBRATION UNIT MX-2919/ASW-12 (V) (0)	ea	NX	1		
	6615-752-7613		CONTROL, ALTITUDE, AUTOMATIC PILOT C-3106/ASW-12 (V) (0)	ea	NX	1		
	6615-771-4634		CONTROL, ATTITUDE REFERENCE C-3108/ASW-12 (V) (0)	ea	NX	1		
	6615-752-7612		CONTROLLER, FLIGHT, AUTOMATIC PILOT C-3107/ASW-12 (V) (0)	ea	NX	1		
	6615-771-4636		COUPLER, NAVIGATIONAL CU-792/ASW-12 (V) (0)	ea	NX	1		
	6615-752-7668		GYROSCOPE, DISPLACEMENT CN-601 /ASW-12 (V) (0)	ea	NX	1		
			RUNNING SPARES AND ACCESSORY ITEMS					
			AUTOMATIC FLIGHT CONTROL SYSTEM AN/ASW-12 (V)					
			NO PARTS AUTHORIZED FOR STOCKAGE AT FIRST ECHELON					

APP—A glide path approach mode providing vertical control of the aircraft so that the aircraft will automatically fly the glide slope path of an ILS system.

Attitude—The position of the aircraft pitch, roll, and yaw axes with respect to fixed references.

Axis—An airplane is considered to have three mutually perpendicular axes, each passing through the center of gravity. The longitudinal axis, sometimes called the "X-axis," runs lengthwise in the plane of symmetry from fore to aft; the lateral axis, sometimes called the "Y-axis," runs from side to side; the vertical or normal axis, sometimes called the "Z-axis," runs in the plane of symmetry from the back to the belly.

BAR—A barometric mode providing vertical control of the aircraft by measuring changes in barometric altitude from a selected altitude.

Collective-pitch control—A helicopter control for changing the pitch of all the rotor blades simultaneously.

Command signal—A signal introduced into the automatic flight control system by the pilot resulting in a specific control of the aircraft through the system.

Control channel—An internal channel in the automatic flight control system to provide a movement of the aircraft controls in a particular flight axis or function such as: pitch, roll, yaw, collective pitch, and rpm.

Control monitoring—The pilot, when engaging or disengaging the automatic flight control system or when flying on automatic flight control near the ground or other aircraft, follows through or monitors the cockpit controls by allowing his hands and feet to ride on the controls.

Disengage—To return the aircraft to manual control or place the automatic flight control system or control channel in standby status.

Engage—To select or place the automatic flight control system or a control channel in operation.

Glidepath—The center of the radio beam which provides the correct glide angle for aircraft approach to the runway.

Hardover—A violent movement of the aircraft controls because of manual or automatic flight control system application which would cause a drastic change in aircraft attitude.

HDG—See "heading."

Heading—Course or direction of flight; compass bearing.

ILS—Instrument landing approach system. A system for guiding aircraft during a final approach. Specifically referring to the glidepath and localizer signals from the ILS receivers.

Lateral axis—See "axis."

LOC—A localizer beam mode providing lateral control of the aircraft so that the aircraft will automatically fly the ILS localizer beam.

Longitudinal axis—See "axis."

NAV—A navigational mode providing lateral control of the aircraft automatically to a ground path preset by a Doppler navigational system.

Overpower—Forcing or holding the aircraft controls away from the position sought by the automatic flight control system.

Overpower response time—The time required for the aircraft to assume an automatic flight control system-controlled attitude or altitude after release of the aircraft controls.

Pilot release switch—A pushbutton on the pilot's and copilot's controls which, when closed, will disengage the automatic flight control system.

Pitch—The movement of an aircraft about its lateral axis.

RAD—A radar altimeter mode providing vertical control of the aircraft so that the altitude of the aircraft will automatically be controlled by a radar altimeter.

Roll—The movement of an aircraft about its longitudinal axis.

Rpm—Revolutions per minute, specifically with reference to rotation rate of helicopter rotors.

Servoeffort indicator—Zero-centered dc voltmeter deflecting to either side of the index thereby showing the amount of automatic flight control system effort.

Side acceleration—The movement of the aircraft on a horizontal plane which generates a centrifugal-type force.

Stabilization—The results of the automatic flight control system effort in maintaining the equilibrium of the aircraft in an established flight mode.

Synchro—An electrical device used for electrical transmission or reception of the angular position data or rotating parts.

Synchronization—During manual flight, the automatic flight control system continually adjusts or synchronizes its flight references to the existing pitch or heading attitude and to the existing altitude. At engagement, the automatic flight control system will take over smoothly, with no aircraft deviation from the existing attitude or altitude.

VOR—VHF omnidirectional radio range. Specifically referring to the signals from the VOR receiver.

Yaw—The movement of an aircraft about its vertical axis; thereby, to change heading.

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For explanation of abbreviations used see AR 320–50.

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